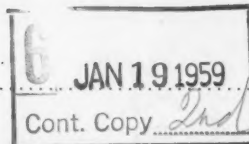


Sci Bill

SCIENCE

16 January 1959

Volume 129, Number 3342



Editorial	Cast of Thousands	121
Articles	How Does a Raindrop Grow? <i>R. R. Braham, Jr.</i>	123
	Precipitation in natural clouds may develop from ice crystals or from large hygroscopic aerosols.	
	Science and Public Policy: <i>J. R. Killian, Jr.</i>	129
	Recent actions by the Federal Government in helping science and technology help the nation are surveyed.	
News of Science	AAAS Council Resolutions; other events	136
Book Reviews	B. F. Skinner's <i>Verbal Behavior</i> , reviewed by <i>D. E. Dulany, Jr.</i> ; other reviews	143
Reports	Oxygen Isotope Fractionation in Reactions Catalyzed by Enzymes: <i>D. E. Feldman, H. T. Yost, Jr., B. B. Benson</i>	146
	Condyllostoma—an Enemy of Bivalve Larvae: <i>V. L. Loosanoff</i>	147
	Influence of Genetic Strain and Environment on the Protein Content of Pulses: <i>G. C. Esh, T. S. De, U. P. Basu</i>	148
	Changes in Psychological Test Performances of Brain-Operated Schizophrenics after 8 Years: <i>A. Smith and E. F. Kinder</i>	149
	Taste Thresholds for Phenylthiourea among Ashkenazic Jews: <i>P. H. Saldanha and W. Beçak</i>	150
	Newly Found Action of Cocaine: <i>T. Koppányi and G. C. Feeney</i>	151
Departments	Letters	116
	Darwin-Wallace Centennial; Forthcoming Events; Equipment	154

Using Centrifugal Force?

**You'll Separate
More Materials Faster
with an**

ULTRACENTRIFUGE

*Rotor is quickly set in place
without tools or connections;
no critical balancing required.*



GENERAL PURPOSE FIXED-ANGLE ROTORS

Large capacity for initial processing of biological materials. 940 ml in 10 tubes; 51,000 x G max.



Combines high force and high capacity for isolating viruses, microsomes. 462 ml in 12 tubes; 105,000 x G max.



Extremely high force allows separation of proteins, small viruses. 162 ml in 12 tubes; 144,000 x G max.



SPECIAL PURPOSE FIXED-ANGLE ROTORS

Shallow tube angle (40°) results in minimum stirring at end of run. 143,000 x G max.



Steep tube angle (20°) for maximum sedimenting efficiency. 142,000 x G.



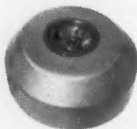
SWINGING BUCKET ROTORS (2)

Ideal for zone centrifugation employing density gradients, and other special studies. Forces to 173,000 x G.



BATCH ROTOR

Capacity to 1600 ml, 35,000 x G.



With speeds ranging from 400 to 40,000 rpm, the Beckman/Spinco Model L Ultracentrifuge can fulfill both your routine and advanced preparative needs. Here are a few of the advantages of this unusually flexible instrument:

High force when you need it—At top speeds, 144,000 Gs are developed with standard rotors (others to 173,000). These forces are more than sufficient to separate proteins and other materials which are well beyond the capabilities of instruments generating less force.

High force to cut operating time—Many routine separations can be accomplished faster at higher forces, reducing operating time as much as 80 percent.

Equal effectiveness at lower force—Large-volume rotors handle separations requiring only nominal speeds. Turn of a knob varies speed to any desired rpm.

Ultra-simplicity of operation—Less than 30 seconds required for start-up; subsequent operation fully automatic, operator's presence not needed.

Economical, maintenance-free operation—The Model L is a heavy-duty, precision instrument which can be run at high speeds for hundreds of hours without attention.

We'd like to send you an APPLICATION CHART which gives helpful data on a variety of materials run by Model L users. References are included.

For the chart and a new 12-page brochure on the Model L, please write to Spinco Division, Beckman Instruments, Inc., Stanford Industrial Park, Palo Alto, California. Ask for file L-5.

Beckman*

Spinco Division

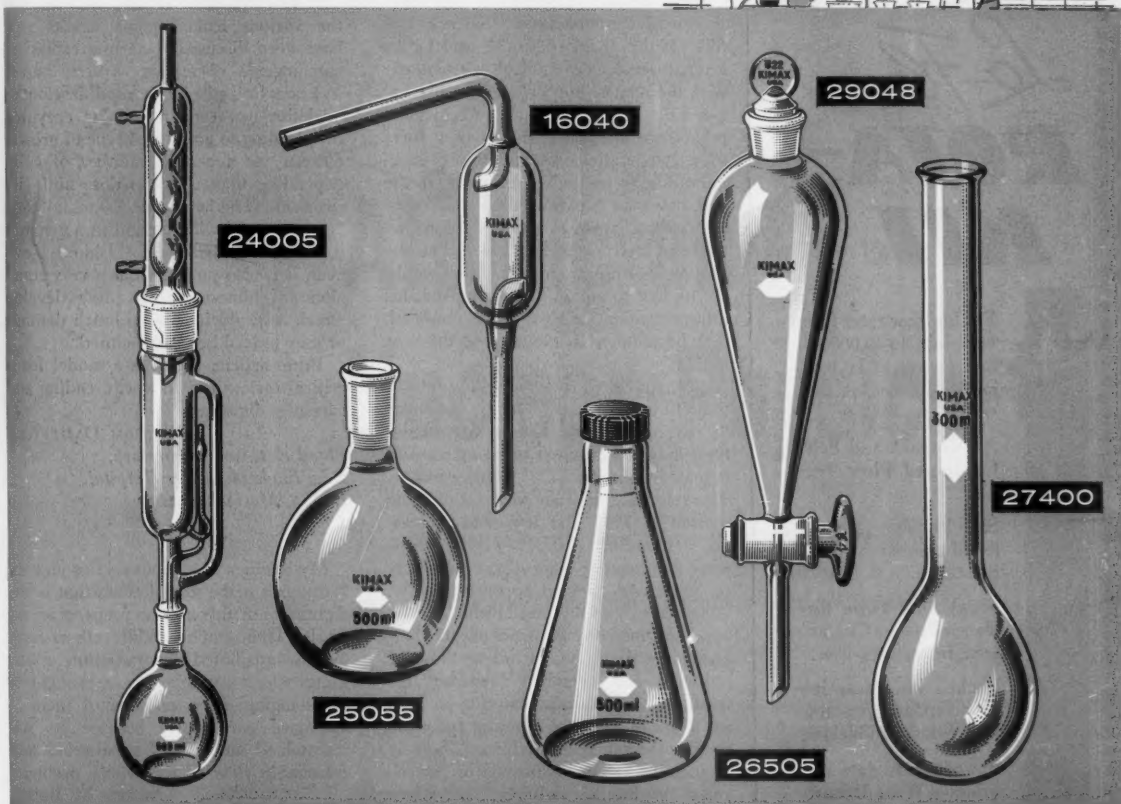
Beckman Instruments, Inc.

S-57

SALES AND SERVICE FACILITIES ARE MAINTAINED BY BECKMAN/INTERNATIONAL DIVISION IN FIFTY COUNTRIES

Now, Kimble offers KIMAX®

(Made from hard borosilicate glass)...



...laboratory glassware that shrugs off heat shock and chemical attack

New KIMAX "hard" glass apparatus offers exceptional resistance to heat shock, mechanical shock and chemical attack. And it's easy to repair and modify... can be sealed to your present borosilicate apparatus.

24005 EXTRACTION APPARATUS. Condenser jackets and exterior bodies are made of heavy, uniform tubing for greater strength. In new design vapor by-pass channel protects siphon tube. Interchangeable with other makes. In 30, 38, 50mm sizes.

25055 BOILING FLASK. Made to withstand severe thermal shock. Finely ground joints provide vapor-tight fit when used with extraction apparatus. Flat bottom adds sta-

bility. In 125, 250, and 500 ml capacities.

16040 CONNECTING BULB. Lower tube fits special Kjeldahl stopper. Inside tips designed for unrestricted counterflow of liquids and vapors. Glazed tips and uniform tubing provide extra strength. Two bulb sizes, 45 and 55mm.

26505 ERLLENMEYER FLASK. First to be made available with screw-cap finish. Useful for mixing and storing culture media and for many chemical purposes. Supplied with caps. Available in 125, 250, 500, and 1000 ml capacities.

29048 SEPARATORY FUNNEL. Large neck openings and sloping shoulders permit easy cleaning. Stems are sized to permit liquid column to break and drain after shut-off.


Stopper hand-lapped to neck for leak-proof fit. In 60, 125, 250, 500, 1000 ml capacities.

27400 KJELDAHL FLASK. Necks tooled to insure accurate stopper fit. Reinforcing beads at top and uniform walls minimize breakage. Chemical resistance of KG-33 glass greatly reduces etching. Seven sizes, from 10 ml capacity to 800 ml.

KIMAX enables Kimble to offer greater savings because of its more complete line. Ask your dealer about quantity discounts. Kimble Glass Company, your most complete source of laboratory glassware, is a subsidiary of Owens-Illinois, Toledo 1, Ohio.

KIMAX is available through dealers in the United States, Canada and principal foreign cities.

KIMBLE LABORATORY GLASSWARE

AN  PRODUCT

OWENS-ILLINOIS

GENERAL OFFICES • TOLEDO 1, OHIO

SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: \$8.50; foreign postage, \$1.50; Canadian postage, 75¢.

ACE Lo-Flow ROTA- KIT®



For low flow rates from 10cc/min. to 40,000cc/min. for gas, and 0.1cc/min. to 1,400cc/min. for water.

A Compact and Self-Contained Flow Test Kit.

Safe Pressure rate 100 lbs. Maximum corrosion resistance.

Float and Tube Replacements are Guaranteed Interchangeable.

Packed in Attractive Wooden Case. Available from Stock in Vineland

For complete data and prices — Write Department ARK-E

Also in stock at our
MIDWESTERN DIVISION
Louisville, Ky.

ACE GLASS
INCORPORATED
VINELAND ♠ NEW JERSEY

Midwestern Division
LOUISVILLE, KY.—Box 996

Letters

Leukemia and Radiation

Brues article "Critique of the linear theory of carcinogenesis" [*Science* 128, 693 (1958)] is an admirable and highly critical review which deals particularly with the relationship of human leukemogenesis to ionizing radiation. Many good points are made indicating that there may be a nonlinear relationship of radiation dose to leukemic end result. In the end, however, one is faced with the usual difficulty of trying to assess which of the different interpretations derived from the same sets of data is correct. Brues would be the first to admit, I am sure, that his interpretations, however well reasoned, may be as far from the mark as the next man's.

The statement is made (page 694) that "this steady increase [in incidence of leukemia in the United States] has been loosely attributed to an increase in human irradiation (17)" (*italics mine*). The reference is to an editorial of mine written in 1947 ["Is leukemia increasing?" *Blood* 2, 101 (1947)] in which some comment is made upon an article by Sacks and Seeman appearing in the same issue. Various possibilities for the apparent increase in incidence of leukemia are discussed, including those of radiation and chemical exposure. Indeed, most emphasis is placed upon various forms of chemical exposure and their possible leukemogenic effects. There is no mention (in this editorial) of "an increase in human radiation" as Brues rather "loosely" states. However, the prophetic statement is made, shortly after the event and before any cases of leukemia were described, that "it will be of interest to observe the Japanese survivors of the atomic bomb for future indications of proliferative disease of the white cells."

Brues may have reference to another editorial published more recently [W. Dameshek and F. W. Gunz, *J. Am. Med. Assoc.* 163, 838 (1957)] in which the suggestion was broached that the apparent increase in incidence of leukemia may be due, at least in some measure, to the increasing exposures of affluent populations to diagnostic and therapeutic x-radiation. Although some of the conclusions were admittedly speculative, it seemed fitting in this editorial to emphasize the potential dangers of radiation therapy for nonneoplastic disease and of unnecessary and frequently repeated diagnostic x-ray procedures.

In our recent book *Leukemia* [W. Dameshek and F. W. Gunz (Grune and Stratton, New York, 1958)] Gunz and I discuss the matter of leukemogenesis and ionizing radiation at length and conclude from all the available data

that only about 15 percent of the cases of leukemia can reasonably be ascribed to radiation and that there are other etiologic agents such as chemical exposure and heredity which it is just as important to emphasize. It may well be that the various leukemogenic agents that have been discussed (ionizing radiation, carcinogenic chemicals, viruses, heredity) act by inducing a modification or "deletion" of certain cellular enzymes, thus leading to an altered type of growth pattern for a certain number of cells, depending upon (i) the dose and (ii) the tissue. The leucocytic tissues, already "generalized," will respond in a generalized—that is, leukemic—fashion. However, it is also possible that a very small clone of abnormal cells may develop which is insufficient to do much damage or may indeed be overwhelmed.

Brues article, which is a model for a critical review, is well worth reading and carefully digesting.

WILLIAM DAMESHEK

*Blood Research Laboratory,
New England Center Hospital,
Boston, Massachusetts*

My blunder in attributing this view to Dameshek is the sort of thing that is the nightmare of anyone who prepares an extensive bibliography. While others have loosely attributed to radiation many things which are changing or thought to be changing, he is not one of them. I apologize particularly because he has maintained and voiced a balanced and reasonable view of the whole problem.

AUSTIN M. BRUES

*Division of Biological and Medical
Research, Argonne National Laboratory,
Lemont, Illinois*

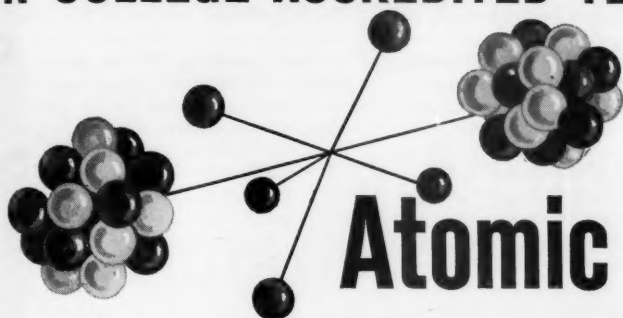
Excessive Education Department Requirements

Recently I wrote a letter to *Science* [128, 1156 (1958)] mentioning, among other things, the excessive education department requirements for science teacher certification. It was implicit in the discussion that university science departments had produced thousands of fine science teachers who are barred from secondary-school teaching positions in most states because they would not spend a fifth to a quarter or more of their university time taking education department courses.

Subsequently, the 85th Congress passed Public Law 85-864, which by its own terms may be cited as the National Defense Education Act of 1958. Certain provisions of this act create concrete financial difficulties for student borrowers because of the excessive education department requirements.

Beginning February 11th on CONTINENTAL CLASSROOM:

A COLLEGE-ACCREDITED TELEVISION COURSE IN



Atomic and Nuclear Physics

If you'd like to learn more about atomic and nuclear physics . . . if you're working towards an advanced degree . . . call your NBC-TV station now for full information. More than 250 colleges and universities are now accepting registrations for audit or credit.

Course will provide:

Technical knowledge of atomic and nuclear physics—with demonstrations, experiments, and special lectures on new developments by Nobel Prize winners and other distinguished physicists.

Conducted by:

Dr. Harvey E. White, vice chairman of the physics department at the University of California, consultant to the Atomic Energy Commission, and author of the most widely used college text on physics.

College credits:

More than 250 colleges and universities are cooperating with the American Association of Colleges for Teacher Education to accept enrollments of, provide examinations for, and assign credits to any TV students who satisfactorily complete the course. Tuition will be set by each institution. Call your NBC-TV station for details.

Televised coast to coast:

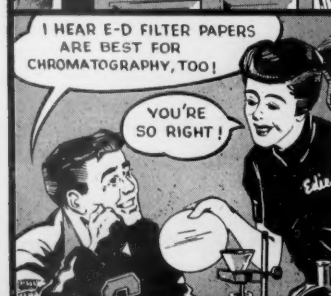
Over 150 commercial and educational stations, in conjunction with NBC-TV, will present this course, 1/2-hour each weekday, from February 11th to June 5th. Check local TV listings for time and channel of CONTINENTAL CLASSROOM. The first semester, now in session, can show you how the course is conducted. Why not tune in tomorrow?



U. S. STEEL proudly joins the Ford Foundation, the Fund for the Advancement of Education, and five other corporations in financing this splendid program—and in urging you to enroll. Call your NBC-TV station now for more information.

EDIE FILTER

POPULAR CLARIFIER OF MANY PROBLEMS



For more information, and FREE samples of E-D Filter Papers, write to

THE EATON-DIKEMAN CO.
Filtertown
Mt. Holly Springs, Pa.

"First with filter paper exclusively"

Title II of the act provides for student loans of up to \$5000, and in section 205 (b) (3) provides for cancellation of the obligation to repay up to 50 percent of the loan as a reward for specified time spent in teaching in public elementary or secondary schools. Thus, a student borrower who after graduation goes into teaching is entitled to what amounts to a bonus of up to \$2500. Yet regardless of the fact that a science department believes the man well qualified to teach science, he must also satisfy the education course requirements, which have been lobbied into the regulations in most states. The student who won't give time to all the required education department courses is penalized up to \$2500, and his services are lost to the public-school system. The student who must heed the \$2500 bonus provision must spend time on education department courses which might be better spent on solid subject-matter courses. The Defense Education Act thus becomes in effect a force feeder for the already disproportionately large education departments.

It seems more important than ever that scientists and science departments rather than educationists should prescribe the qualifications for science teachers—that a science department teaching recommendation be admitted in lieu of an arbitrary number of education courses for teacher certification. The American Association for the Advancement of Science can properly advise state regulatory bodies that the quality of teaching will be improved, not lowered, by elimination of all education department courses not deemed necessary by the science department to fit each individual case.

WILLIAM W. PORTER II
Los Angeles, California

Scientific Communication

A recent editorial [*Science* 127, 1145 (1958)] and a letter by D. Lebo [*Science* 128, 424 (1958)] have called attention to increasingly critical problems of scientific communication. Some attributes of an improved communication system are (i) capability of evolving from the existing system; (ii) reduction of delays in communicating results; (iii) coverage of a broad range of scientific interests (reversal of the trend toward overspecialized journals); (iv) guarantee of self-determination to the individual author (elimination of editor-referee censorial power and of pressure toward source-material abridgment); (v) guarantee of self-determination to the individual subscriber (elimination of unwanted material from his mail, unlimited availability of wanted material); (vi) incurrence of no added cost.

The following hypothetical system illustrates the possibility of reconciling these apparently divergent requirements. The contributor prepares a full account of his research, sparing no detail. He also prepares an abridgment of perhaps two pages and a conventional abstract. The full account receives an identification number and is permanently filed in a central repository. The abridgment is printed, with its number, in a bound journal resembling (except for its broader scope) the appropriate existing journal. Thus, the necessary evolutionary link with the present system is provided. The abstract is not, as now, adjoined to the article but is printed, with identification number, on a separate card.

The journal subscriber receives with each issue the corresponding stack of abstract cards (optionally he might wish to receive only the cards). These may advantageously be border-punched cards [G. Cohn, *J. Franklin Inst.* 266, 133 (1958)], partially prepunched to provide rough classification assistance. Most of the border holes are left unpunched, to allow the subscriber to apply his own information-retrieval methods and adapt his punching system to his personal needs and mnemonic habits. (The required tools are simple: a punch and a sorting needle. To retrieve abstracts in a given category, form cards into a deck in any order, pass the needle through the appropriate hole, spread and lift the deck; the punched cards fall out.)

By postcard, included with the abstract cards, subscribers request photocopies (or other facsimile reproductions) of those full accounts that interest them. If the latter prove scientifically exceptional, the volunteer "referees" have a professional obligation to communicate their suggestions to the authors. Profiting from such criticisms, authors may issue revisions to supersede their earlier accounts. The constructive aspects of the present refereeing system are thus retained and enhanced, since a maximum number of maximally interested referees are effectively consulted. The editor, too, plays a more constructive role. He can select for full publication articles worthy of general attention, or those for which the demand exceeds the resources of economical facsimile copying, but he suppresses nothing and delays nothing.

Subscribers might be entitled to annual allowances of facsimile material, extra requests being charged on a per-page basis. The reprint problem is solved automatically. Savings in type-setting costs resulting from the abridgment policy might offset the cost of abstract cards.

It is hoped that these suggestions may encourage scientists to experiment with evolutionary improvement of traditional publication procedures.

T. E. PHIPPS, JR.
Falls Church, Virginia



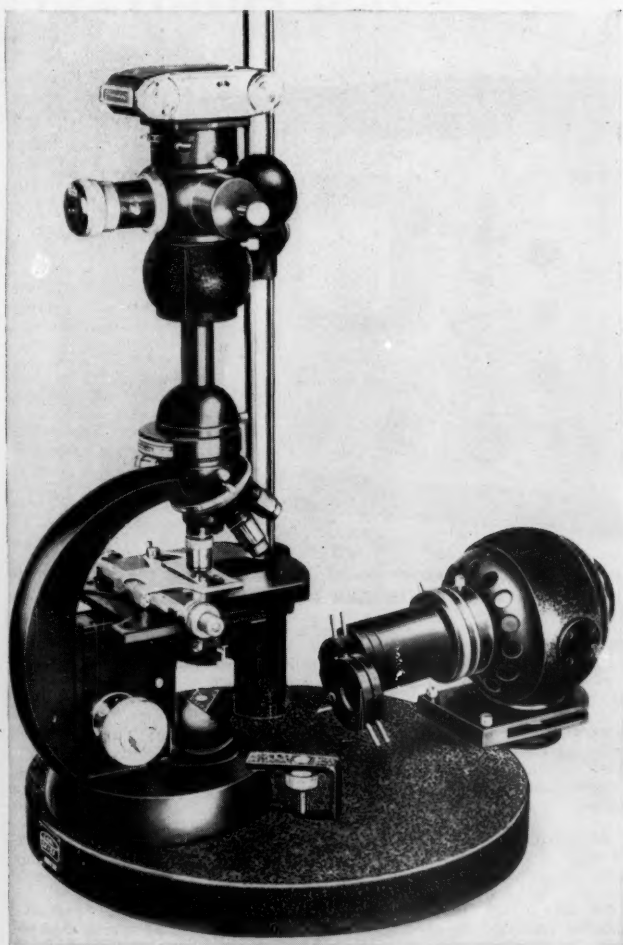
WEST GERMANY

Large Equipment for Fluorescence Microscopy

The Carl Zeiss Large Fluorescence Equipment fulfills to the highest degree the requirements of modern fluorescence microscopy in brightfield as well as dark-field.

Exciter filter combinations make it possible to select the most suitable ultra-violet or blue-violet range of the spectrum emitted by a high intensity mercury vapor burner. In addition, a specially designed filter tube, with rotatable discs containing barrier filters, not only protects the human eye but allows quick selection of filter combinations to obtain highest contrast of the specimens under examination. The purity of the produced fluorescence is not only of the optimum but of such high intensity that photomicrographs can be made in color or black-and-white.

Another outstanding advantage is the fact that every existing Carl Zeiss objective can be employed—not only Achromats but also highly corrected objectives such as Apochromats, Neofluars, and Planachromats. This makes it possible to observe true colors produced by fluorescence and at the same time makes the purchase of objectives suitable for fluorescence unnecessary.



Write for free detailed literature

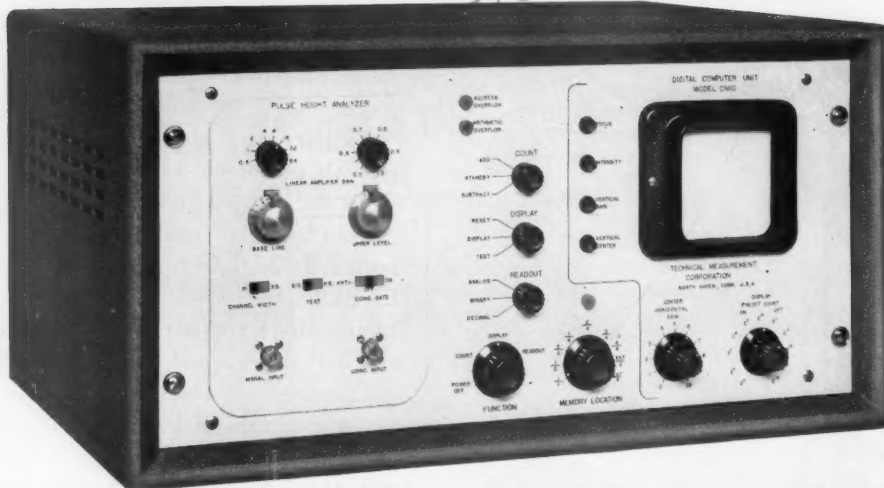
CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17, N. Y.

GUARANTEED
UNINTERRUPTED
REPAIR SERVICE

- only 8¾" high
- uses interchangeable plug-in logic units
- provides complete versatility and portability

... A Transistorized 256-Channel Pulse Analyzer



MODEL CN-110
256-CHANNEL ANALYZER
WITH PLUG-IN MODEL 210
PULSE HEIGHT ANALYZER UNIT

THE BASIC CN-110 IS THE MEMORY containing all the elements for complete magnetic core data storage — memory current drive, cycle control binaries, address and arithmetic binaries, power supplies, etc.

PLUG-IN LOGIC UNITS make several different analyzers available in the time it takes to interchange units. Standard plug-in units are available for Pulse Height Analysis, Time of Flight Measurements, Count as a Function of Time; units for special programs can be built to order.

CARRY THE SYSTEM TO THE OPERATION — the completely transistorized Model CN-110 weighs only 40 lbs. (including logic unit), and is only 8¾" high. It is easily carried by one person to any location. With auxiliary readout system, total weight is approximately 100 lbs. — over 1500 lbs. less than equivalent systems using vacuum tubes.

NO COOLING PROBLEMS — the complete use of transistors in the Model CN-110 reduces heat dissipation — air conditioning or bulky blowers are not required; total power less than 10 watts.

MANY TYPES OF READOUT may be used — analog . . . binary . . . octal and decimal. Data can be recorded on strip chart or X-Y recorders . . . printed paper tape . . . magnetic computer tape . . . punched paper tape . . . punched cards. The Model 220 *Decimal Converter*, available as an accessory, is designed specifically for use with the CN-110. It includes a paper tape printer which prints channel number and count number on the same line (with 3-space separation). During the counting period, the Model 220 also functions as a live time indicator and automatic dead time corrector.

Write for complete data on the Model CN-110 and standard plug-in logic units. For details on custom logic units and data readout programmers, outline your specific requirements.



TECHNICAL MEASUREMENT CORPORATION

441 WASHINGTON AVE., NORTH HAVEN, CONN.

AMERICAN ASSOCIATION
FOR THE
ADVANCEMENT OF SCIENCE

Board of Directors

PAUL E. KLOPSTED, *President*
CHAUNCEY D. LEAKE, *President Elect*
WALLACE R. BRODE, *Retiring President*
H. BENTLEY GLASS
GEORGE R. HARRISON
MARGARET MEAD
THOMAS PARK
DON K. PRICE
MINA REES
WILLIAM W. RUBEY
ALAN T. WATERMAN
PAUL A. SCHERER, *Treasurer*
DAEL WOLFE, *Executive Officer*

DAEL WOLFE, *Executive Officer*

GRAHAM DUSHANE, *Editor*

JOSEPH TURNER, *Assistant Editor*

ROBERT V. ORMES, *Assistant Editor*

Editorial Board

DONALD J. HUGHES H. BURR STEINBACH
KONRAD B. KRAUSEKOPF WILLIAM L. STRAUS, JR.
EDWIN M. LERNER EDWARD L. TATUM

Editorial Staff

SARAH S. DEES, LUCILLE GUINARD, NANCY S. HAMILTON, WILLIAM HASKELL, OLIVER W. HEATWOLE, YUKIE KOZAI, JUDITH B. LEVIN, ELLEN E. MURPHY, BETHSABE PEDERSEN, MADELINE SCHNEIDER, NANCY L. TEIMOURIAN, MARIA A. WOLSAK.

EARL J. SCHERAGO, *Advertising Representative*

SCIENCE, which is now combined with THE SCIENTIFIC MONTHLY, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. The joint journal is published in the SCIENCE format. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879. SCIENCE is indexed in the *Reader's Guide to Periodical Literature*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

Display-advertising correspondence should be contributed to SCIENCE, Room 740, 11 West 42 St., New York 36, N.Y.

Change of address notification should be sent to 1515 Massachusetts Ave., NW, Washington 5, D.C. 4 weeks in advance. If possible, furnish an address stencil label from a recent issue. Be sure to give both old and new addresses, including zone numbers, if any.

Annual subscriptions: \$8.50; foreign postage, \$1.50; Canadian postage, 75¢. Single copies, 35¢. Cable address: Advancesci, Washington.



Cast of Thousands

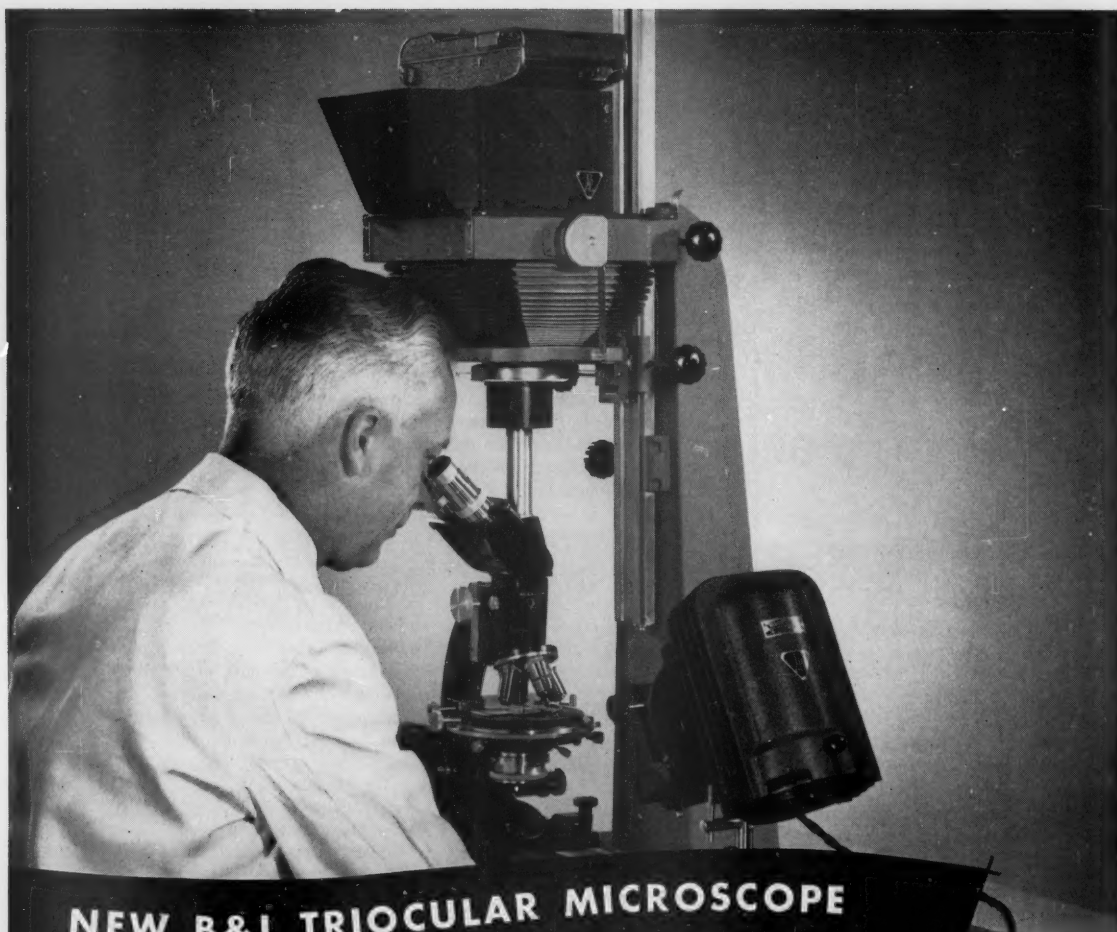
In June of this year the United Nations expects to finish publishing in 33 volumes, at the advance subscription price of \$435, the 2135 scientific papers submitted to the Second International Conference on the Peaceful Uses of Atomic Energy held in Geneva last September. Six volumes in the set are already off the press. The size and speed of this effort make it a considerable feat, the previous record being the production and distribution in 16 volumes of the proceedings of the 1955 atomic energy conference. Although publication of the conference proceedings involves political as well as scientific considerations, it is still fair to ask what will be the place of this record effort in the scientific literature.

One way in which plans to publish the proceedings were probably affected by political considerations was the decision to publish all the scientific papers that were submitted. Since the papers were submitted to the U.N. by governments, not by authors, any attempt to screen them might have been interpreted as a reflection upon the merit, or lack of merit, of particular countries. The participating governments, of course, exercised discretion in deciding which of the papers by their citizens should be sent to the conference, and the governments did assign priorities on the basis of which the U.N. invited papers for oral presentation. But again because of a mixing of political with scientific considerations, the fact that a paper was presented orally did not necessarily mean that it was superior to a paper not so presented.

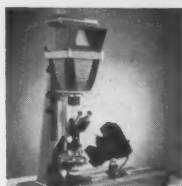
Publication of the conference proceedings is itself something of an international venture, involving the work of presses in five countries. In addition to the complete English edition, with 15,000 figures and tables and the discussions that followed delivery of papers, the project includes abridged French and Spanish editions in 15 volumes. United Nations officials estimate that the costs for paper and printing will be around \$1.3 million. What papers a Russian edition will include is not yet clear, but its cost is not figured in the present estimate.

The point raised by publication of the proceedings which is of immediate interest to practicing scientists concerns the place of the proceedings in the scientific literature. The decision to include all papers submitted means that papers of little value will be published alongside papers of great value. Since the papers of little value, of which, according to observers, there is an abundance, would not be published in the established scientific journals, there is some doubt that they should be published here. The papers of great value not only would be accepted by the scientific journals, but many indeed are being published in these journals and within approximately the same time span. With the presence of poor papers and the duplication of good papers, the proceedings are not likely to prove of great use. The main advantage of the publication may lie in bringing all the Geneva papers together in one place, but the great bulk decreases this advantage.

How much distribution of the full proceedings of the conference will contribute, not merely to the forward course of science, but to the promotion of international understanding is a harder question to answer. Suffice it to say that people at the United Nations have good hopes for recovering through sale of the volumes their paper and printing costs, and that sales are going mainly to governments, libraries, and industrial concerns. We do not know whether some future U.N. scientific conference will prove even larger than the last one, but if it does we expect to find it followed by an even greater publishing achievement.—J.T.



NEW B&L TRIOCULAR MICROSCOPE LIGHTENS YOUR RESEARCH LOAD



FASTER PHOTOMICROGRAPHY

The Triocular Body, combining binocular eyepieces for comfortable visual use and a monocular photographic tube, lets you scan, orient and focus in the usual way. When ready to take a picture, just a glance at the Reflex Back of your camera and **CLICK!** That's it! There's no guesswork, no waste of time or film. You photograph exactly what you see—and what you see is unequalled in image quality.



ON-THE-SPOT CONSULTATION

With the new B&L Triocular microscope and Model N Eyepiece Camera, you and a colleague can study the same subject, at the same time, through the same microscope. Invaluable for collaboration, especially in studies of moving material. Ample light (with B&L Professional Illuminator) even for phase contrast, dark-field, deeply stained specimens.

PLUS ALL THE EASE AND COMFORT EXCLUSIVE WITH B&L DYNOPTIC DESIGN

As in all B&L Dynoptic Microscopes, controls are positioned low to let your hand rest on the table throughout orientation and fine focusing. Ball bearings and rollers "float" the focusing system for effortless operation. World's finest optical system makes prolonged observation easy on your eyes.

(Complete Triocular Microscope, or interchangeable Triocular body, available in B&L Dynoptic Laboratory and Research Microscope models.)

BAUSCH & LOMB



Dynoptic

RESEARCH MICROSCOPES

MAIL COUPON FOR DATA AND DEMONSTRATION

BAUSCH & LOMB OPTICAL CO.
75937 St. Paul St., Rochester 2, N. Y.

- ☐ Send me B&L Dynoptic Triocular Microscope Catalog D-1084.
- ☐ Schedule a demonstration, in my lab, at my convenience.

NAME, TITLE
PROFESSIONAL
ADDRESS

CURRENT PROBLEMS IN RESEARCH

How Does a Raindrop Grow?

Precipitation in natural clouds may develop from ice crystals or from large hygroscopic aerosols.

Roscoe R. Braham, Jr.

The formation and growth of natural raindrops, and the possibility that man can exercise some degree of control over their formation, is one of the most fascinating developments of modern meteorology. So great is the present interest in the subject that a considerable number of meteorologists, chemists, and physicists have turned their research efforts toward this goal. Although control of the weather still appears to be a long way off, the intensive research in cloud physics of the past few years has given considerable insight into the processes of formation of natural precipitation. Thus, it has only been within the past few years that anything approaching a satisfactory answer to the question of raindrop growth has been available.

To understand how a raindrop grows, we must first consider how clouds and cloud droplets are formed. Most clouds are made up of small droplets of water which form through condensation of water vapor upon atmospheric aerosols as the air parcels containing these small particles move upward in the atmosphere (see Fig. 1A). In the case of very high clouds (for example, cirrus), the small droplets quickly freeze so that the cloud is composed of very small ice crystals. Since the atmospheric pressure decreases with height, and since the capacity of air for holding water vapor

decreases with decreasing temperature, it follows that upward-moving air parcels will undergo adiabatic expansion and cooling, with a consequent increase in relative humidity.

Under most conditions in the lower atmosphere, lifting to the extent of a few thousand feet will bring air to saturation; further lifting and cooling would produce a condition of supersaturation, except for the fact that the atmosphere always contains copious numbers of solid particles which serve as nuclei for inducing the formation of the liquid phase at very low values of supersaturation—of the order of less than 0.5 percent. This remarkable efficiency of atmospheric condensation nuclei is attributable to the fact that many of them are hygroscopic—probably small particles of sea salt and sulfate-bearing compounds. As soon as a sufficient number of these nuclei have been activated to absorb the water vapor as fast as it is made available by the rising air parcel, the supersaturation begins to wane, and no additional nuclei are activated.

The mechanism of droplet growth is largely Fickian diffusion of vapor toward the droplet in response to a difference in vapor pressure between the droplet and its environment. It is the nature of such growth that the rate of change of size of a growing droplet is inversely proportional to its radius. Therefore, other things being equal, the small drop-

lets grow faster than the large ones, and the entire system tends to reach a uniform or "average" size. Thus, in a cloud which is not developing precipitation, the number of droplets per cubic centimeter is determined by (i) the speed of the updraft, which fixes the rate at which water is made available to the cloud, and (ii) the amount and nature of the particulates within the air, or, in other words, the relative numbers of "favorable" and "unfavorable" nuclei. The average final size is determined by the amount of lifting (condensation) following the initial activation (for this determines the mass of water condensed per unit volume in the updraft), by the number of droplets upon which the condensation occurs, and, to a minor extent, by the age of the individual cloud parcels.

Since upward motions within the atmosphere vary by orders of magnitude from one meteorological situation to another, and even from one cloud to another on a given day, and since the amount and nature of atmospheric particulates vary considerably, depending upon the previous history of the air, it is natural to expect considerable variation in the cloud-droplet spectra within various clouds. This is exactly what is found (1). A typical distribution curve for cloud droplets is shown in Fig. 2. In general, nonprecipitating convective clouds are characterized by large numbers of fairly small droplets, the breadth of the distribution depending upon cloud size.

The data for nonprecipitating stratus clouds are rather scarce, except for a series of measurements by Diem (2). Such clouds appear to be characterized by relatively fewer droplets of a wide size range.

Formation of Rain through Ice Crystals

The only essential difference between a cloud droplet and a raindrop is one of size. Whereas cloud droplets range in radius up to 20 or 30 microns, raindrops are of the order of a few millimeters in

The author is associate professor of meteorology at the University of Chicago.

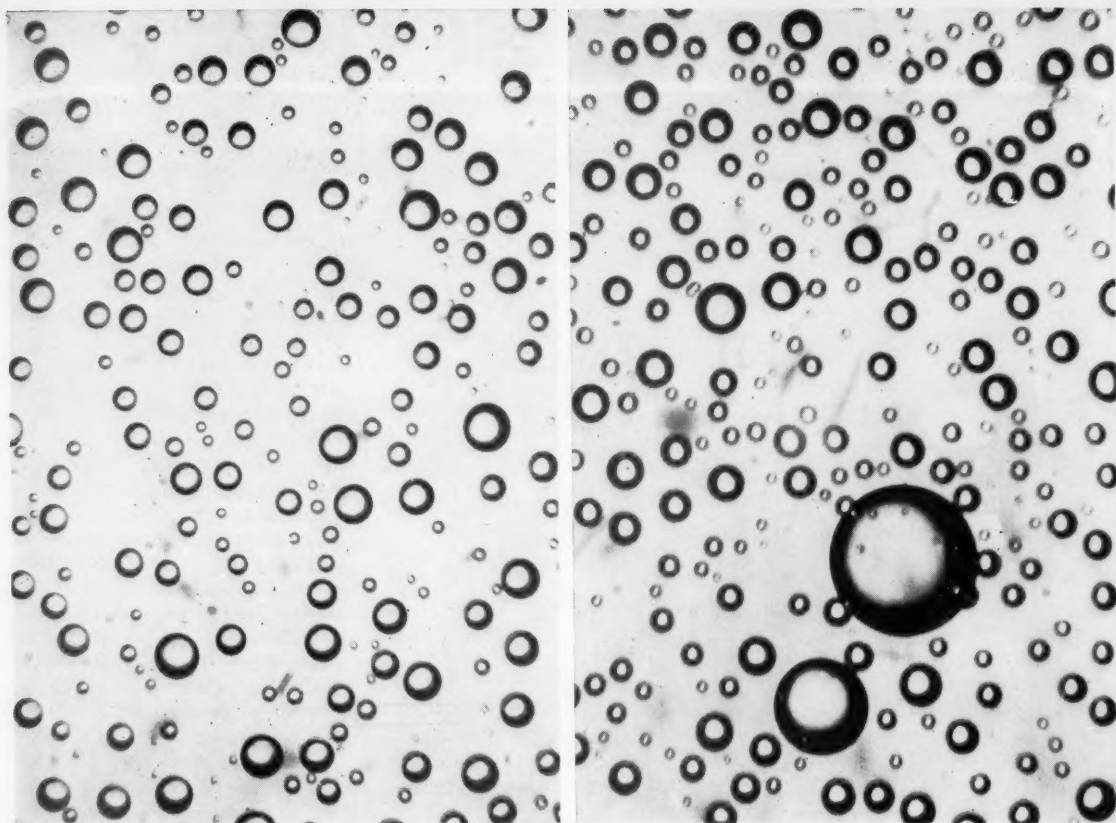


Fig. 1A (left). Typical microphotograph of cloud droplets collected in a nonprecipitating cloud. Fig. 1B (right). Microphotograph of two incipient precipitation particles in a collection of cloud droplets. Cloud droplets in actual clouds are not as close together as is suggested by these photographs. These droplets were obtained by exposing oil-coated slides to the slipstream as an airplane flew through the clouds.

radius. In mass, an average raindrop is about 10^6 times as large as an average cloud droplet. In the early 1930's it was thought that raindrops resulted from continued condensation upon cloud droplets until they were large enough to fall as rain. Now we know that this is not the case. Somehow nature selects only a very few of the droplets for continued growth. Occasionally the cloud physicist, sampling a nonprecipitating cloud, is fortunate enough to find one of these favored droplets. An example of such a droplet is shown in Fig. 1B. Aside from the two large droplets, this droplet system is remarkably similar to that in Fig. 1A. We must now tackle the problem of why a particular droplet is favored for growth over thousands of others.

This problem, concerned with the overcoming of the colloid-like stability of natural clouds, has long been recognized as one of great importance. In 1911, the German chemist Wegener called attention to the fact that the

saturation vapor pressure over ice was less than that over a subcooled liquid water surface at the same temperature (3). Because of this difference, small ice crystals in the presence of subcooled water droplets will grow at the expense of the droplets, the droplets evaporating as the crystals grow by sublimation. In 1933, Bergeron, a Swedish meteorologist, noted that subcooled water clouds were very common in nature and, aware of the inherent stability of a condensing system of water droplets, suggested that all rain had its origin in the melting of snowflakes (4). This idea, further developed by the German meteorologist Findeisen, has since become known as the Bergeron-Findeisen, or ice-crystal, theory of precipitation formation.

According to this theory, the atmosphere contains a limited number of special particles which are capable of inducing the nucleation of ice directly from the vapor by means of sublimation. These particles are called "sublimation

nuclei." It was supposed that no significant amounts of rain could fall from a cloud until the top of the cloud reached a level where these nuclei could become effective. Once ice crystals were formed within a subcooled cloud, they would continue to grow because their environment, saturated with respect to water, would be supersaturated with respect to ice. It was thought that the end product of this process would be a group of snow flakes which would melt as they fell through the "freezing" level and continue to the ground as rain. In the event that temperatures at the ground were below freezing, the particles would arrive as snow instead of rain.

Ice Nuclei

Although subsequent research has shown that ice crystals are not the only route of precipitation formation, the importance of ice and snow as weather

phenomena has prompted a moderate amount of inquiry into the number and nature of ice-forming nuclei, the manner in which they work, and the structure of the ice particles which grow from them. Additional work along these lines is sorely needed.

Apparently there are two kinds of ice nuclei in the atmosphere—those which induce freezing of the liquid phase and those which induce the direct formation of crystals from vapor. Thus far researchers have not devised a suitable method for distinguishing between them, and it is customary to consider them collectively as ice nuclei. Measurements of natural ice nuclei are usually made by cooling a known volume of air, introducing water vapor to form a cloud, and counting the number of ice crystals which appear at various subfreezing temperatures. These measurements show that nuclei effective at temperatures higher than about -10°C are scarce, rarely exceeding 10 per cubic meter. The number of effective nuclei increases with decreasing temperature, reaching values of about 10^4 per cubic meter at -25°C . Some investigators find a marked increase in the number of nuclei as the air temperature falls below -25°C and attribute this to the fact that the threshold temperatures of many kinds of terrestrial dusts, presumed to be important in the formation of ice, are in this temperature range (5).

As a consequence of the scarcity of effective ice nuclei, clouds reaching upward beyond the freezing level undergo extensive undercooling. In general, however, measurements made inside clouds reveal more snow than would be expected from the laboratory counts of ice nuclei. Whether this is due to poor counting techniques or to some unidentified process operating within the clouds is not clearly known.

Laboratory studies show that the mean freezing temperatures of water droplets are related directly to the size of the droplets (6). In the mean, a raindrop of 1-millimeter radius will freeze at a temperature of about -15°C , whereas small cloud droplets freeze at much lower temperatures—for example, a droplet of 5-micron radius, on the average, will freeze at about -35°C . The freezing temperature apparently depends upon the droplet volume—the larger the droplet the greater the probability that it will contain one of the few nuclei effective at a comparatively warm temperature.

The homogeneous freezing temperature for water is approximately -40°C .

When a cloud rises to heights where these temperatures prevail, or whenever a cloud first forms at these temperatures, the droplets quickly freeze. Such clouds are known as cirrus and probably are very important sources of ice nuclei for atmospheric precipitation processes.

The role of the occasional droplet which freezes at a warm temperature (from -10° to -20°C) is not understood, but in all probability it is an important one. Research now under way at the University of Chicago suggests that such particles form the first few large particles for precipitation growth in convective clouds. It is thought that the differences between nuclei counts and flight observations of snow may be reconciled on the basis of this hypothesis.

Unexplainable Observations

From the time of the meetings of The International Union of Geodesy and Geophysics in Lisbon in 1933, at which Bergeron presented his paper, until the early years of World War II, the ice-crystal theory of rain production remained unchallenged. It was commonly observed that cloud tops usually extended well above the 0°C isotherm before rain was observed at the cloud bases. Unfortunately, knowledge about nucleation and crystal growth was inadequate to test the theory in terms of the amount of time required, and the character of the clouds necessary, for the production of rain by this mechanism. Textbook authors and scientists of

the period apparently were convinced that the question of rain production was largely settled. Unfortunately, nature didn't read the textbooks.

During the war years, weather observers were sent throughout the world in a stepped-up program of weather observing. For the first time there was a vast increase in the number of trained weather observers, and large numbers of airplanes were available to carry the observers in, around, and over the clouds. From the tropical regions came reports that rain was occasionally observed from clouds whose tops were wholly warmer than freezing—in other words, in clouds where it was impossible for ice nuclei to have formed.

At the same time, important developments were taking place in another area. Early in the war the engineers developing radar for the detection of ships, and planes were disturbed to find that, under certain conditions, clouds would return significant amounts of radar energy—in fact, radars at the shorter wavelengths were largely useless for surveillance purposes because of weather return. Troublesome as this was for the radar designers, it proved to be fortunate indeed for the meteorologist. For the first time it was possible to examine the interior of a cloud without the necessity of flying into it. Immediately following the war, the Thunderstorm Project was organized by the U.S. Weather Bureau, the Air Force, the Navy, and the National Advisory Committee for Aeronautics, with Horace Byers (University of Chicago) as its director (7). Radar studies on convective clouds, carried out by that project in 1946 and 1947, proved conclusively that many clouds develop rain without the involvement of ice crystals. Extensive subsequent research has now demonstrated that rain from "warm" clouds is very common, particularly in the tropical regions (8).

Project Cirrus

Another postwar event of major importance in meteorology took place in the Schenectady laboratories of the General Electric Company. There Irving Langmuir and Vincent Schaefer were engaged in military research concerning the effects of weather phenomena on aircraft flight. This work led inevitably to studies of cloud formation and of ice-crystal formation in the atmosphere. There, in November 1946, Schaefer performed the first experiments designed to

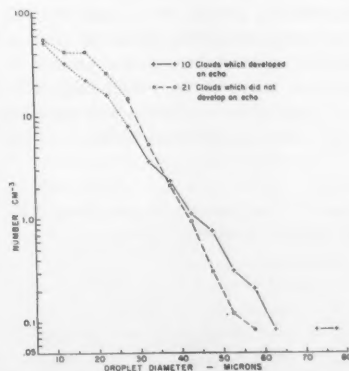


Fig. 2. Typical cloud droplet size distribution. This particular distribution represents collection made in rapidly building cumulus clouds. Note that clouds which precipitate (develop radar echoes) contain slightly fewer small droplets and slightly more large droplets than the non-precipitation clouds.

test the Bergeron-Findeisen theory of precipitation. It was shown that subcooled clouds could be turned into systems of small ice crystals, either by reducing the temperature below -40°C or through the introduction of suitable ice nuclei. Schaefer showed beyond a shadow of doubt that subcooled stratus clouds could be caused to snow-out through seeding with Dry Ice. The Dry Ice caused the formation of many ice crystals by virtue of cooling some of the air to below -40°C . In the same laboratory, Vonnegut found silver iodide smokes to be very effective as sublimation nuclei at temperatures as high as -4°C .

Thus, within the space of a single year, it had been shown that the ice-crystal mechanism was capable of creating precipitation in subcooled clouds, while at the same time it was found that precipitation in some natural clouds occurred under circumstances such as to preclude the involvement of ice.

Rain without Ice Crystals

Just as some of the atmospheric dust particles have special properties that cause the formation of ice crystals, others of them are hygroscopic. These are called "giant condensation nuclei." Because of their large sizes they behave differently from the other hygroscopic nuclei in two important ways: (i) Because of their larger mass, their ultimate size as solution droplets in vapor-pressure equilibrium with their environment will be much larger than that of the other, smaller, condensation nuclei; and (ii) the rate at which they approach their equilibrium size is much slower than that of the smaller nuclei. Measurements of atmospheric nuclei and calculations based upon these measurements suggest that the nuclei which account for the overwhelming majority of cloud droplets

have masses of the order of 10^{-13} to 10^{-17} moles, if they are composed of NaCl. These correspond to dry sizes (for masses assumed to be spherical) of the order of 0.8- to 0.04-micron radius. A series of computations by Howell (9) showed that these particles would grow into cloud droplets of sizes up to about 10-micron radius after 1000 seconds and that thereafter growth of the droplets would tend to stabilize, the final radius being between 10 and 15 microns. The exact final sizes depend upon initial conditions and the updraft speed.

Atmospheric particulate counts made since the time of Howell's work, however, show that the atmosphere contains a limited number of hygroscopic particles ranging in size up to 10 microns in radius (dry size). Extensive measurements reported by Lodge (10) and by Byers, Sievers, and Tufts (11) show that air over the Caribbean and over the humid eastern part of the United States may contain up to 10^3 chloride particles of greater than 5-micron radius (dry size) per cubic meter. Similarly, large numbers of giant sulfate particles are found in the same regions. The exact size to which a NaCl particle of 5-micron radius will grow in 1000 seconds, if it is rising in an air parcel with an average number of the smaller aerosols, is unknown, although approximate calculations suggest a size of about 25-micron radius. However, the drops formed upon the large nuclei will continue to grow by condensation, reaching appreciably larger sizes after the other droplets have stopped growing. (At 99.99 percent relative humidity, the equilibrium radius for this droplet would be about 50 microns; however, over 5000 seconds would be required for growth to this size through condensation alone.) Thus, in air containing natural hygroscopic aerosols in a wide range of sizes, there is a built-in mechanism whereby, given sufficient time, the cloud-droplet distribution can

be broadened sufficiently to overcome the colloidal stability of the droplet system.

Growth by Collision and Coalescence

As we now understand the physics of clouds, there are two ways in which incipient precipitation particles can be formed in cloudy air—namely, through the formation of ice crystals on sublimation nuclei and through the formation of solution droplets on giant condensation nuclei. The effect of either of these is to broaden the size spectrum of the cloud particles. Once this has been accomplished, another factor comes into play to permit further growth of the large particles.

The falling speed of particles is a direct function of particle size. Every particle within a cloud is falling relative to its environment. Even the smallest cloud droplet is falling with respect to the air about it. However, the falling speed of cloud particles, droplets, and small crystals is so low that it is more than compensated for by the upward motions of the air within the clouds. However, when some of the particles grow to be significantly larger than the rest, they will fall through the cloud and collide with some of the slower-moving particles. Some of these collisions will be elastic, but a certain fraction of the intercepted droplets will aggregate with the larger particle and cause its further growth. Both the relative approach speed and the collision efficiency increases with increasing differences in size between the collecting and collected particles. Once an incipient precipitation particle reaches a size sufficiently larger than the bulk of the cloud droplets to permit collision with them, its further growth is assured. Only when it falls through the base of the cloud, or when the cloud evaporates from around it (as through mixing with dry outside air), will the growth of the particle be interrupted.

How large must an incipient precipitation particle be before it will grow appreciably through collision and coalescence? Studies made by Houghton and others (12) suggest that once a droplet has attained a size of 30 to 50 microns in radius, growth by collision and coalescence will be much faster than growth by condensation. By the time a droplet reaches a radius of 100 microns, growth by coalescence is very rapid and condensation may be entirely neglected.

The ultimate size to which a droplet can grow by coalescence within a cloud

Table 1. Approximate fall distances and times required for growth of drops of initial 25-micron radius in a uniform cloud composed of droplets of 10-micron radius.

Drop radius (μ)	Water content			
	1 g/m ³		3 g/m ³	
	Fall distance (ft)	Fall time (min)	Fall distance (ft)	Fall time (min)
25	0	0	0	0
50	500	24	200	8
100 (Drizzle)	1640	40	540	13
250 (Rain)	4400	48	1470	16
500	8300	55	2700	18

depends largely upon the liquid water content of the cloud and the depth of cloud through which the droplet falls. Since the terminal speed and collision efficiency of a droplet are essentially functions only of its size, it is possible to compute the distance through which a droplet of any given size must fall, within a cloud of specified cloud water content, to grow to any larger size. Table 1, adapted from some early work by Langmuir, gives this distance for clouds of water content 1 and 3 grams per cubic meter, respectively. The larger values apply to isolated cores within convective clouds. Stratus clouds average considerably below 1 gram per cubic meter. It is immediately obvious that rain is unlikely to fall from stratified decks of less than about 5000 feet in thickness. Rain can form in convective clouds of much less depth, however, both because of the greater average water content and because the updraft, which is always much stronger in cumulus clouds than in stratus, may hold the growing drop within the cloud for a considerable period of time.

Collision with smaller particles is also important in the growth of precipitation through the ice-crystal mechanism. Once an ice crystal has reached a size of about 100 microns in radius, its falling speed relative to the cloud droplets will be sufficient to cause it to collide with them. The results of these collisions depend upon several factors, of which the most important are the height at which the collision takes place (and consequent temperature and pressure), the relative sizes of the colliding particles, and the number of collisions per unit time. At temperatures lower than about -10°C to -15°C in typical mid-latitude cumulus clouds, ice particles smaller than about 2 millimeters in radius will be able to dissipate the latent heat of fusion of the colliding droplets, and the ice particle will grow into a snow pellet. Snow pellets are white, opaque agglomerates of frozen droplets and ice crystals, often giving the appearance of a closely packed bunch of grapes. When such a particle falls into lower regions, where the temperature is higher than about -10°C , it will be unable to dissipate the latent heat of fusion of all the intercepted water, and the result will be partial freezing into a clear ice structure, with the excess water streaming off the rear side. Such a particle has been termed a "wet hailstone." The larger the particle initially, and the greater the water content of the cloud, the lower the temperature at which the snow pellet be-



Fig. 3. Small cumulus cloud of the trade-wind region which has developed rain through the all-water mechanism. Temperature of the cloud top, about 10°C . By raining, such a cloud destroys itself.

gins to collect clear ice and to become wet. Should a particle, in falling through a large cumulus cloud, find itself in a succession of areas of differing water content, such that it alternately becomes wet and dry, a true hailstone of the concentric-layered type may form.

After falling into regions where the temperature of the cloud droplets is higher than freezing, the colliding droplets will carry heat to the wet snow pellet and hasten its melting.

Snow pellets, both dry and partially melted, reach the ground in mid-latitudes rather frequently in the spring and fall months. They are usually associated with thunderstorms and other convective-cloud weather.

In stratified clouds the common forms of solid precipitation are relatively large single crystals of ice and clusters of small ice crystals, either of which is commonly known as snow. Extensive research by Nakaya and his associates has shown that the crystal form of snow is largely determined by the temperature and degree of supersaturation of the air in which the crystals grow (13). The endless variety of detail in crystals apparently is due to the continuous fluctuation of vapor densities in the microvolumes through which they fall.

Clumping of snow crystals into large aggregates occurs only at temperatures between 0°C and -5°C . Research by

Hosler and others suggests that ice particles are coated with a liquid film which materially assists adhesion in this temperature range. At temperatures lower than -5°C , very little clumping occurs. However, the maximum rate of growth of individual snowflakes will occur at temperatures of about -15°C , because the difference between saturation over ice and over water reaches a maximum value at approximately this temperature.

Ice Crystals versus Solution Droplets

Following the publication of the Bergeron-Findeisen hypothesis, the theory that all significant amounts of rain involved the prior formation of snowflakes in the subcooled regions of the clouds was accepted. During and immediately after World War II it was found that many clouds, particularly in tropical regions, developed rain long before the tops had grown to heights where ice could have been involved. At the present time several research groups are busily engaged in detailed studies of the microphysics of clouds in an effort to determine the relative importance of these two mechanisms of precipitation development. Far from being a purely academic question, the matter assumes importance in relation to attempts to induce precipitation in clouds which



Fig. 4. Towering cumulus cloud forming over mountains in Arizona. Cloud base, near 5°C ; cloud top, near -15°C . In spite of their large size, such clouds seldom contain precipitation. Precipitation first forms when the top of the cloud reaches a temperature of about -20°C . [E. L. Harrington]

would not have precipitated naturally, and in attempts to otherwise modify the behavior of clouds. Studies by the Cloud Physics Laboratory at the University of Chicago have shown that virtually every cumulus cloud in the tropics develops rain by the all-water process (14). Most of the cumulus clouds of the trade-wind regions (Fig. 3) produce measurable amounts of rain by virtue of the large hygroscopic particles. Riehl has shown, however, that most of the rain in the tropics occurs in connection with organized convection which extends well above the freezing level. In all probability, these clouds also first develop rain through the all-water process; however, it is also a virtual certainty that these same clouds subsequently develop snow pellets in their upper regions. The fraction of the total rain at the ground that results from the snow pellets is unknown.

Battan has shown that most of the summer thunderstorms in Ohio first develop rain in a manner best explained by the all-water mechanism (15). Here again, measurements made from airplanes flown through the storms show that snow pellets are a very common form of precipitation in the upper

reaches of these clouds. As yet the data are not adequate for determination of the relative roles of the two mechanisms.

Arizona is the only other region in which extensive measurements have been made of randomly selected cumulus clouds (16) (Fig. 4). These measurements show that initial precipitation develops at temperatures lower than 0°C but not so low as to rule out the all-water mechanism. Flight observations in these clouds show that snow pellets are invariably observed about the same time that precipitation echoes first show up on the radars.

The only detailed flight examination of mid-latitude cyclonic disturbances made to date was carried out by Cunningham (17). It was his observation, on a limited number of flights in the New England states during the winter months, that most of the precipitation at the ground had its origin in snow aloft.

Summary

On the basis of presently available data, combined with present-day knowl-

edge of the physics and chemistry of cloud particle development, it is possible to make the following generalizations about the mode of precipitation in natural clouds.

1) The all-water mechanism begins to operate as soon as a parcel of cloud air is formed and continues to operate throughout the life of the cloud. The ice-crystal mechanism, on the other hand, can begin to operate only after the top of the cloud has reached levels where ice nuclei can be effective (about -15°C). Some clouds never reach this height; any precipitation from them must be through the all-water mechanism. In cold climates and at high levels in the atmosphere, the cloud bases may be very close to this critical temperature. In the tropics, approximately 25,000 feet separate the bases of low clouds from the natural ice level.

2) The number of large hygroscopic nuclei in maritime air over tropical oceans is entirely adequate to rain-out any cloud with a base below about 10,000 feet, provided the cloud duration and cloud depth is sufficient for the precipitation process to operate. Extensive trajectories over land will decrease the

number of sea-salt particles, both because of sedimentation and removal in rain. Measurements show an order-of-magnitude decrease in the number of large particles as maritime air moves from the Gulf of Mexico to the vicinity of St. Louis, during the summer months. Measurements in Arizona and New Mexico show even smaller chloride concentrations, presumably because of the long overland trajectories required in reaching these areas. The maritime particles lost in overland trajectories apparently are more than replaced by particles of land origin. The latter are usually of mixed composition and are less favorable for the formation of outsized solution droplets.

3) Ice nuclei, required for the formation of ice crystals and for droplet freezing, are rather rare at temperatures higher than about -10°C . This, of course, accounts for the fact that natural clouds undergo extensive undercooling. Because of the scarcity of suitable nuclei, precipitation through the ice phase usually is not found in clouds warmer than about -15° to -20°C . Natural cirrus clouds might provide ice nuclei for precipitation at somewhat higher temperatures, but this possibility has not been extensively studied.

4) Precipitation in tropical clouds invariably first develops through the all-water mechanism; points discussed in

paragraphs 1, 2, and 3 above all work toward this end. Tropical clouds which reach to heights above about 25,000 feet also develop precipitation through snow pellets.

The data for mid-latitude clouds are conflicting. Some measurements suggest that summer clouds in the central United States and in the semiarid Southwest develop rain largely through the all-water process; existing theories support such a suggestion. However, flight measurements indicate that there is considerably more ice and snow in the clouds than can be accounted for by present theory; as a consequence, one must be careful in ruling out the ice mechanism in these areas. It appears to me, however, that the ice particles in these clouds are best accounted for through the hypothesis of freezing of drops which have grown to fairly large size through diffusion of vapor. Thus, the ice would be only incidental to the precipitation development.

Winter clouds in the central United States and almost all of the clouds of northern United States and Canada appear to precipitate largely through the ice-crystal mechanism. The relatively cold cloud bases and the continental sources of air masses in these regions appear to retard the warm-rain mechanism to the point where the ice mechanism dominates. But here again, a great

deal of research must be completed before a firm conclusion can be drawn (18).

References and Notes

1. L. J. Battan and C. H. Reitan, "Droplet-size measurements in convective clouds," in *Artificial Stimulation of Rain* (Pergamon, New York, 1957), pp. 184-191; B. J. Mason, *The Physics of Clouds* (Oxford Univ. Press, New York, 1957).
2. M. Diem, *Meteorol. Rundschau* 1, 261 (1948).
3. A. Wegener, *Thermodynamik der Atmosphäre* (Barth, Leipzig, 1911).
4. T. Bergeron, "On the physics of clouds and precipitation," *Proc. Intern. Union of Geodesy and Geophys. 5th Assembly, Lisbon* (1935), pt. 2, pp. 156-178.
5. V. Schaefer, "The Occurrence of Ice-Crystal Nuclei in the Free Atmosphere," *Project Cirrus, Gen. Elec. Co. Occasional Rept. No. 20* (1950).
6. E. K. Bigg, *Proc. Phys. Soc. (London)* 66B, 688 (1953).
7. H. R. Byers and R. R. Braham, Jr., *The Thunderstorm* (Government Printing Office, Washington, D.C., 1949).
8. H. R. Byers and R. K. Hall, *J. Meteorol.* 12, 176 (1955).
9. W. E. Howell, *ibid.* 6, 134 (1949).
10. J. P. Lodge, *ibid.* 12, 493 (1955).
11. H. R. Byers, J. R. Sievers, B. J. Tufts, "Distribution in the atmosphere of certain particles capable of serving as condensation nuclei," in *Artificial Stimulation of Rain* (Pergamon, New York, 1957), pp. 47-72.
12. H. G. Houghton, *J. Meteorol.* 7, 363 (1950).
13. U. Nakaya, *Snow Crystals* (Harvard Univ. Press, Cambridge, 1954).
14. R. R. Braham, Jr., *Geophys. pura e appl.* 35, 126 (1956).
15. L. J. Battan, *J. Meteorol.* 10, 311 (1953).
16. R. R. Braham, Jr., *ibid.* 15, 75 (1958).
17. R. M. Cunningham, "The Distribution and Growth of Hydrometeors around a Deep Cyclone," *Mass. Inst. Technol. Weather Radar Tech. Rept. No. 18* (1952).
18. The research reported in this article was sponsored in part by the Geophysics Research Directorate, Air Force Cambridge Research Center, under contracts No. 19(604)-1388 and 19(604)-1931.

Science and Public Policy

Recent actions by the Federal Government in helping science and technology help the nation are surveyed.

James R. Killian, Jr.

Those of you who planned this joint meeting of Phi Beta Kappa-Sigma Xi had a happy inspiration. You reduced the number of scheduled annual speeches by one—an act of the purest sort of humanism not easily come by—and you exemplified Laertes' observation that "a double blessing is a double grace." By joining forces tonight you doubly bless the theme of this AAAS meeting and en-

dow with grace your proclamation that man and his world are one and that science and humanism are complementary, each dependent upon the other.

You also have placed the speaker who didn't cancel in a position of double responsibility, if not double jeopardy. That I had the temerity to accept your invitation bespeaks my sense of privilege in speaking on this occasion.

To relate my remarks to the theme of this AAAS meeting, I wish to discuss some of the ways in which the affairs of men and the affairs of science interact in the area of public policy-making. This is a subject very much in vogue today. It is a topic of conferences, and universities appropriately are beginning to establish special programs dealing with science and public policy. My approach, however, is not academic; I come to you fresh from the firing line, where I have been engaged day in and day out in marshaling scientific advice for the Federal Government. I report to you on this experience—on the work of the Office of the Special Assistant to the President for Science and Technology and of the President's Science Advisory Committee. Until November a year ago, this office never existed in its present form in the

Dr. Killian is Special Assistant to the President for Science and Technology. This article is adapted from an address delivered 30 Dec. 1958 before the 125th annual meeting of the American Association for the Advancement of Science, in Washington, D.C.

Federal Government, nor had there been, save in wartime, a Science Advisory Committee directly responsible to the President.

Before reporting on these particular activities, however, I wish to list some of the efforts which have been made since Sputnik to strengthen science and to relate it more effectively to policy-making. These efforts have been made in many places—in the Executive Branch, in Congress, in international organizations, and wherever our scientists do their work. They have been directed at multiple objectives: to enhance the excellence of our science, both basic and applied, and to add to our effort, relatively, in basic research; to extend the recognition of science as a creative activity that augments man's dignity and understanding and affords him intellectual adventure of the highest order; to recognize that outstanding accomplishments in science appeal deeply to the hopes and aspirations of men everywhere and contribute to the prestige and good will of nations; to demonstrate that the democratic environment of the free world is the best environment for achievement in science; to improve the ways in which our Government uses and supports science; to apply it more effectively to improve our environment, to strengthen our economy, to improve the health and welfare of our citizens and the peoples of the free world; to promote international understanding and good will; to insure that science and technology contribute their maximum to the defense of the United States and the free world.

I pause to recall these objectives because the campaign in which we are engaged to strengthen science and use it wisely must embrace them all if it is to achieve full success.

And now let me summarize some of the events and some of the efforts made since Sputnik to strengthen our science and its use, especially on the part of the Federal Government.

In two speeches during November a year ago, President Eisenhower called for a many-pronged effort to insure that the best resources of science and scientific manpower be mobilized in support of national security and welfare. He emphasized the importance of strengthening science education and of bringing our over-all scientific and technological effort up to peak performance. As he said later in his State of the Union message, "In both education and research redoubled exertions will be necessary on the part of all Americans if we are to rise to the de-

mands of our times." He called for better exchange and better cooperation among the scientists of the free world. In calling for the most effective possible use of science and technology in behalf of national security he stressed at the same time the vital need for basic research and the contributions which science can make to a better life for all men. Through these messages he heightened public awareness of the need for better science and better science education and he made specific proposals for action.

In the months that followed, these proposals were translated into action.

Record of Progress

The program of the National Science Foundation was expanded. The funds available to it were increased from a total appropriation of \$50 million in fiscal 1958 to \$136 million in fiscal 1959. As a result, the Science Foundation has been able to increase its support of basic research and expand its programs for science-teacher training and other efforts contributing to the quality of science education. The National Science Foundation has really come into its own, and is now one of the Government's major means for advancing science and for supporting basic research.

The Department of Defense Reorganization Act reflected the impact of modern weapons technology and "systems engineering" on military organization, and by providing for the new office of the Director of Research and Engineering, to which a scientist, Herbert York, has just been appointed, stressed the importance of high-level formulation of research and development policy and supervision of the over-all program of defense research and development. During the year, also, the Department of Defense brought into operation the Advanced Research Projects Agency to sponsor long-range research for defense and to undertake projects of common interest to the military services.

Last spring, upon the recommendation of the Administration, Congress passed legislation creating the National Aeronautics and Space Administration to provide a civilian-directed and civilian-oriented space science and exploration program. The new NASA continues the work of its predecessor, the National Advisory Committee on Aeronautics, and in the same manner as this latter agency, it provides research support for military aeronautics and space programs.

The Act which created the NASA also established the National Aeronautics and Space Council, a body advisory to the President and presided over by him. This council is unique in that its membership includes both government officers and members from outside of government, including civilian scientists. Those who remember the congressional debates over the organizational form of the Atomic Energy Commission and the National Science Foundation will find much of interest in the legislative provisions for the NASA and for this new council.

Altogether the year brought an impressive array of organizational innovations for the management of government programs in science and technology and for the provision of scientific advice at policy-making levels. The NASA, the National Aeronautics and Space Council, the Advanced Research Projects Agency, and the new post of Director of Research and Engineering in Defense, the Science Adviser in the State Department, the Special Assistant to the President for Science and Technology, the reconstituted President's Science Advisory Committee, and the newly authorized Federal Council for Science and Technology, which I shall discuss presently—all these taken together convey the sense of urgency to improve the management and promotion of science by the Federal Government.

In listing these organizational changes it is appropriate to recall the thoughtful comment of Don K. Price that, "in the organization of the government for the support of science we do not need to put all of science into a single agency; on the contrary, we need to see that it is infused into the program of every department and every bureau. We do not need to insulate it from executive authority; on the contrary we shall protect it best from political interference and enable it to be most effective if we give it a direct and effective relationship with the responsible executives, as well as the support of well organized groups of advisers from the leading private institutions of the nation."

Next in the record of the year's accomplishments is the National Defense Education Act. While designed to aid education generally, this act contains important provisions specifically directed at strengthening science education—as, for example, the matching grants it makes available to the states for refurbishing and re-equipping high-school science laboratories.

The State Department reestablished

the Office of Science Adviser and appointed to this office the president of the American Association for the Advancement of Science. It also authorized the appointment again of scientific attachés. About a fortnight ago, announcement was made by the Department of the appointment of seven of these attachés.

NATO has strengthened its organization for promoting the use of science, both by NATO itself and by the member countries. During the year a Science Adviser to the Secretary General of NATO was appointed, and a NATO Science Committee was established. In addition to these NATO actions, the year brought significant increases in the science program of the Organization for European Economic Cooperation.

In many ways the most striking accomplishment of the year was the program of the International Geophysical Year. This has been an unprecedentedly productive and successful international effort. While governments have helped to support the program, it has been carried out by a nongovernmental international organization, the International Congress of Scientific Unions. The success of ICSU in coordinating this worldwide program suggests the pattern for future international programs in science. During the year ICSU established international committees on Oceanographic Research, on Antarctica, and on Space Research.

In addition to the above, there have been other important advances in international cooperation, notably the second Atoms for Peace Conference in Geneva. It was at this conference that the United Kingdom and the United States joined in announcing the declassification of research in the field of fusion. At this same conference the United States staged a superb exhibit that contributed importantly to the dissemination of information about peaceful uses of the atom and, in doing so, greatly enhanced American prestige abroad.

A number of important actions were taken this past year by Congress and the Executive Branch to improve the status of scientific personnel in the service of government.

The President's Committee on Scientists and Engineers completed a successful year in their efforts to improve the utilization of scientists and engineers across the nation, to enlarge our statistical knowledge of the nation's resources in this field, and to strengthen scientific education and counseling.

The House of Representatives estab-



James R. Killian, Jr.

lished a Standing Committee on Science and Astronautics, thus creating for the first time in Congress a single committee which is concerned broadly with basic science. The Senate also created a new Standing Committee on Astronautics and Space Science, but so far its scope does not encompass the broad range of science. Upon recommendation of the National Science Foundation, Congress also gave authority to government departments and agencies to make grants for scientific research as well as contracts and to vest title to research equipment procured with contract funds with the institution involved.

In assembling here this record of progress, I do not wish to leave the impression that we have done more than make a start on the great task of realizing the full potential of science in the United States and in the free world. Much remains to be done, but the record makes it clear that we *can* make headway. It also illustrates the multiplicity and variety of the things which must be done to bring our science and technology up to peak performance. It demonstrates that we advance by "steps and not by leaps," to use Macaulay's phrase.

Science Advisory Committee

Let me turn now to another part of the year's record and describe the organization and work of the President's Science Advisory Committee since it was reconstituted at the White House level

and since the appointment of the Special Assistant to the President for Science and Technology.

The committee is concerned broadly in making scientific advice and analysis available where they are needed in the formulation of national policy. It is also concerned with the effect of national policies on the nation's scientific and engineering activities.

There has been apparently a misconception abroad that my office and the Science Advisory Committee have operating responsibilities. We do not. We have no operational responsibility, for example, for the development of missiles or satellites. We have, of course, made intensive studies of various aspects of our missile and space programs for the information and use of the President. Neither do we have any responsibility to decide policy. My function and that of the committee is to provide answers to questions raised by the President, to undertake assignments for him of an advisory kind, to mobilize the best scientific advice in the country, and to make recommendations to him in regard to ways by which United States science and technology can be advanced—especially in regard to ways by which they can be advanced by the Federal Government—and recommendations on how they can best serve the nation's security and welfare. This advisory service, the President has indicated, is available also to members of the Cabinet and other officers of Government when they wish it.

One of the principal functions of the Science Advisory Committee is to provide a communications center for science in the Federal Government and thus to facilitate intercommunication among various scientific activities within government and between the civilian scientific community and the Government. It is important to note that the president of the National Academy of Sciences is ex-officio a member of the committee and that the outgoing president of ICSU has also been a member. The director of the National Science Foundation and the Science Adviser of the State Department sit with the committee, and the Director of Research and Engineering of the Department of Defense and the chairman of the Defense Science Board are members. Warren Weaver once observed that "what science needs is not a lot of planning, but a lot of convenient communication, so that controls may arise naturally from feedback." I am sure that I and the members of the Science Advisory Committee share this view.

The 18 members of the committee are representative of those fields of science and technology currently important to the Government. With the exception of certain ex-officio members, the regular members of the committee have limited terms, and thus the membership on the committee rotates. Rotation of members will bring to the committee different points of view and fields of science not hitherto represented. It will also help the committee to avoid ever becoming inbred in its point of view.

In carrying on its work for the President, the Science Advisory Committee is organized into a group of panels which include both regular committee members and other engineers and scientists selected from outside the ranks of the committee. Some of these panels have standing responsibilities; others are called together for *ad hoc* assignments. This panel structure has been a marked characteristic of the work of the committee, and the intensive studies made possible by the individual panels have enabled us to tackle problems which could not be effectively undertaken by the committee itself with its limited membership. The panels are responsible to the Science Advisory Committee, but they draw into our councils a wider range of scientific experience and expert advice than can be provided by a single committee. The committee also serves as a board of consultants to me as Special Assistant to the President. This relationship is highly important. One man should not try to represent science or to provide expert advice in a variety of fields. I draw upon the full range of advice and experience of the Science Advisory Committee and its panels. The committee has the prerogative, when it chooses, to report directly to the President. As special assistant I also have, in addition to the Advisory Committee and its panels, special consultants, task forces, and staff. At the present time the Science Advisory Committee and my office have about 75 scientists and engineers serving part time.

It is important to note that the Special Assistant for Science and Technology is invited to sit in on meetings of the National Security Council and the Cabinet and, when it is appropriate or requested, to present the views and findings of the Science Advisory Committee. The President has thus created a mechanism to bring objective scientific and engineering advice to the top levels of government in a manner that reaches across all agencies and departments and yet can serve each of them.

In creating this new post and in reconstructing the Science Advisory Committee, widening its scope and associating it with the White House, the President has given special recognition to the fact that science and technology, apart from their use in solving specific problems, have a direct and creative impact on the formulation of public policy. The reconstitution of the committee and the establishment of my office have stimulated an extraordinary array of requests within government to make scientific advice available. The problem has been to avoid being overwhelmed by the many requests for advisory services while at the same time trying to respond helpfully and promptly whenever a need exists. The President's Committee has encouraged the strengthening and full use of each department's and agency's own advisory groups.

One of the current concerns of the committee and myself is the difficulty of bringing younger talented scientists and engineers into our own panels and into other types of advisory service to the Government. So many of the scientists and engineers who now serve in advisory capacities are the same ones who held important posts during World War II. Although their wisdom and experience are invaluable, this group is overworked. We have great need for bringing to the service of the Government a new generation, and we need to find methods of doing this which will make their services, skills, and fresh ideas available without handicapping their professional development or curtailing their vital contributions to science. As we widen the net for first-rate talent, we need also to remember that this talent is to be found within the Government as well as outside and that the advisory functions at the top level of government can benefit from groups that represent activities both within and without government.

Work of the Science Advisory Committee

Turning now to the substantive work of the Science Advisory Committee and its panels, let me select the following five examples and report on their work.

First, the panel on space science took the lead last winter and spring in suggesting the elements of a "down-to-earth" program in space science and in providing a basis for proposals which were subsequently made by the Administration on the organization of a space agency.

The panel prepared a statement, "Introduction to Outer Space," for purposes of public information, and this was issued by the President as a formal paper published under the imprint of the White House. This statement has had circulation running into many millions. It has had value, too, in helping the American people share, through understanding, in one of the great adventures of our time. It has also helped, I hope, in distinguishing between what is authentic and sound in space planning and what is fantasy.

Second, the panel on scientific information (the report of which was made public several weeks ago) addressed itself to the problem of how best the rapidly growing volume of foreign and domestic scientific and technical information can be mobilized to meet the critical needs of our scientists and engineers in furthering new research and of how the Federal Government should organize to assist in this mobilization.

I hardly need to point out the problems which arise from the growing volume of scientific publications. Currently there are some 55,000 journals containing articles of significance for some branch of research or engineering in the physical or life sciences. More than 60,000 books are published annually in these fields, while approximately 100,000 research reports remain outside the normal channels of publication and cataloging. The problem is further complicated by the fact that a large and important proportion of the world's scientific literature appears in languages unknown to the majority of American scientists—languages such as Russian and Japanese. Russian-language publications now account for a tenth or more of the scientific literature published in the world. A recent UNESCO report concluded that about 0.1 percent of American scientists and engineers read the Russian language, while approximately 50 percent of Russian scientists and engineers read English. We must now anticipate a growing volume of scientific and technical publication in Communist China, and this will place new requirements on our translating services.

The solution proposed by the panel was based upon the conviction that we should not follow the Soviet pattern of establishing a centralized information center but should seek instead to coordinate the many very excellent programs we already have in this field, among both government agencies and private institutions.

In the course of the panel's review of

the problem, there developed a widespread consensus, not only among the members of the panel but among many representatives of the different agencies of government and of nongovernment institutions, as to what the proper solution would be. As a consequence, much of what the panel finally recommended had already been widely accepted within and without government. This consensus reflected itself in the action of Congress in including Title 9 of the National Defense Education Act, directing the National Science Foundation to establish a Science Information Service. The panel, with the endorsement of the Science Advisory Committee, therefore, recommended to the President that the National Science Foundation expand its information activities to provide a coordinating center for the information services of the Federal Government and appropriate assistance to private information agencies. The President accepted the recommendations of the panel and directed that the National Science Foundation take the leadership in bringing about effective coordination of the various scientific information activities within the Federal Government.

Third, the Science Advisory Committee's panel on research policy has just published a report entitled, "Strengthening American Science," which deals with the role of the Federal Government in research and development. The President has directed that an executive order be prepared to carry out the recommendation of the report that a Federal Council for Science and Technology be established to advise the Cabinet on those aspects of the Government's program which require interdepartmental and Government-wide coordination and policy-making and which affect science as a whole. Membership on the council will include representatives of the departments and agencies which have substantial research activities, these representatives to be drawn from the policy-making levels of these departments and agencies. The council, made up of government officers, can call for advice from the President's Science Advisory Committee, which draws its members largely from the nation's scientific and engineering community outside of government.

While searching for ways to improve public management where it relates to science, the report devotes attention to the nurturing of important new scientific fields and the strengthening of those which are assuming new importance. Meteorology is one example of a field

where additional capital funds and emphasis are necessary. Geology, geophysics, oceanography, materials research, radio-astronomy, studies of the upper atmosphere, and combustion are other examples of fields where augmented support and effort are clearly needed.

Government operations increasingly have brought growing demands for the fruits of research and more support for actual work performed. There has been no comparable provision, however, for new instruments and facilities, except in certain specialized fields. Capital deficiencies, moreover, are being further aggravated by the rapid progress occurring in the improvement and invention of the instruments of science themselves.

The panel urges the formulation of thoughtfully conceived policies for the financing and planning of the great multi-million-dollar research instruments of modern science, such as particle accelerators for nuclear physics, and of centralized research institutes which are needed or proposed in various fields. We are at a point where we need to bring together the best available judgment from the domains of government, education, and science to determine how far we should go in the establishment of research institutes and what their relations should be with the universities. Unsound planning might result in weakening the universities and, by drawing away from them too many research scholars, in reducing their capacity to nurture new scholars.

The importance of the role of private support in the nation's total scientific effort is emphasized. Private foundations are uniquely qualified to provide venture capital, to "grub-stake" new ideas, and to "support men as well as projects."

The growth of federal support of science in recent years has been marked by some hesitancy on the part of private sources of funds to maintain the level of their contributions to academic and other nonprofit institutions. It would be most unfortunate if this hesitancy were to continue or spread, for there are growing opportunities for private philanthropy to contribute to the strength and freedom of American science. It is vitally important, therefore, that government science policy should not discourage private support of science but, indeed, should take pains to encourage more of it.

In making public recently the report of the Science Advisory Committee, the President called particular attention to its conclusion that the task of further strengthening United States science is so broad that government, industry, univer-

sities, foundations, and individuals all have vital roles to play. The future growth of American science will depend upon increased participation and contributions by all of these types of institutions if we are to be equal to the full range of opportunities which lie ahead.

Fourth, we have a very active panel on science and technology in foreign affairs. It is a source of advice on the role of science and technology in supporting our foreign-policy objectives. It seeks to assist government departments and agencies in using science and engineering effectively in our foreign programs and in furthering international cooperation in science and technology.

The interaction between science and foreign affairs is similar to that between science and public policy in general—that is, there are two clear areas of emphasis. One is the impact of scientific progress or scientific activities on foreign policy, on aid to underdeveloped countries, on our military alliances; the other is the requirement placed on our international policies to further and encourage scientific development by creating the necessary climate for effective interchange of ideas and international scientific cooperation.

The panel on science and foreign affairs has been concerned with both aspects of this interaction, as has the President's Science Advisory Committee as a whole. One of the first concerns of the panel was to respond to a request from the State Department to help re-establish the post of Science Adviser in the State Department and to aid in the re-establishment of the Science Attaché program at overseas posts.

The Lacy-Zaroubin agreement negotiated with the U.S.S.R. includes provision for exchange of scientists between the United States and the U.S.S.R. The State Department Science Adviser and the president of the National Academy of Sciences, who is also chairman of our panel, visited Moscow in the fall of 1958 to establish the details of the exchange agreement between the respective academies of science which will bear the major responsibility for the exchange of scientists.

It is well to point out here the close collaboration that takes place continuously between the panel and the National Academy of Sciences. One of the best examples of this collaboration, and of the general activities of the panel, is the consideration which has been given, at the invitation of the International Cooperation Administration, to ways in

which our scientific resources can be better employed in the planning and operations of the United States technical aid programs. The panel studied this question in some detail, consulting with representatives of ICA and other interested agencies. As a result of this, the ICA has sponsored a National Academy of Sciences' study of a particular area; Africa south of the Sahara was selected. This study is now being performed by a full-time staff under the auspices of a special Academy committee.

In summary, the activities of the panel on science and foreign affairs have ranged over the entire broad field of the impact of science on United States foreign affairs and the furthering of international scientific cooperation and exchange. All that has been considered or influenced by the panel cannot be recounted briefly, but it is well to point out that one of the major aids in the work of the panel is the representation on it of those whose regular responsibilities include the day-to-day integration of science and foreign affairs—for example, the president of the National Academy and its foreign secretary, the present and the past Science Adviser in the Department of State, the director of the National Science Foundation, the United States representative on the NATO Science Committee, a past president of ICSU, and a vice president of the ICSU Special Committee on Space Research.

Scientists and engineers have special advantages and opportunities to assist in achieving international cooperation and agreement. The concepts of laws of science cross all national and ideological boundaries. It is the one language understood the world around. It is a means to common understanding and joint action.

In the unrelenting competition which faces the entire free world, nothing less than the full and efficient use of the free world's scientific resources will provide the strength it needs. The full development of science and technology by the free world is essential to its economic and military strength and thus to its political and cultural stability and advance. This is why the achievement of better exchange and cooperation is so important.

Fifth, the panel on science and engineering education is now completing a study aimed at clarifying and highlighting objectives and needs of that part of our educational system which has the responsibility for preparing adequate numbers of first-rate scientists and engineers

and for achieving a high degree of scientific literacy in the United States.

The panel feels deeply that some of the major challenges which face the nation today are on the intellectual front. A greater desire to learn and an increased respect for learning—for intellectual excellence—may now in the long run be essential to national survival; consequently, we need a greater devotion to learning, a greater pride in intellectual achievement, a greater determination to achieve excellence in American life. In any educational enterprise or discussion of education we need constantly to be asking ourselves what we must do to obtain these objectives.

The panel's discussions on science education foreshadow some of the following more specific conclusions.

1) We have not yet faced up adequately to the fact that in the immediate years ahead the rising number of students will outrun the supply of college teachers. While estimates are difficult to make, it is not far off the mark to predict that the number of Ph.D.'s graduating from our universities who are qualified or who elect to go into college teaching will be less than a third of the number of college teachers that will be needed. We must, therefore, find new ways to increase the effectiveness of each teacher we now have. We must increase the time he has available for actual teaching, and we must extend the result of his efforts to more students. We must make better and wider use of every effective teaching aid, and we must invent new ones. There are still unrealized possibilities for bringing the great teacher into effective contact with greatly increased numbers of students.

2) We need to give more national attention to the quality and content of courses and curricula in science, both in high schools and colleges. We need extensive, organized, national efforts to bring together in each subject field the leading scientists and scholars with groups of high-school and college teachers, for re-examining and modernizing the content of courses in the sciences. We need to bring about the preparation of better and more modern textbooks and to find ways of making available better but less expensive laboratory equipment. Taking the country as a whole, there seems to have been a serious decline in the quality of laboratory teaching in recent years. In too many places it has become routine, overmechanized, and sterile.

This combination of requirements call-

ing for bold and large-scale efforts to enable our teachers to teach better and to modernize and improve our curricula in science is pressing upon us now. Our colleges and universities have a very grave responsibility to help, as they have never done before, in meeting these needs. Especially does it seem to be incumbent upon the administrative heads of our institutions of higher learning to give support and encouragement to faculties in assuming the responsibility of planning new courses and course material, both for high school and college, which is in line with the most modern scholarly research and the most modern insights into the science being taught.

3) The nation's responsibilities and opportunities in science have grown to the point where we find ourselves today, in the judgment of the panel, with too few first-quality institutions of higher education in science and engineering. We need more of the same quality as the best we now have. Particularly do we need more top-flight graduate schools. Of the 700 colleges and universities in the United States which offer graduate degrees, something less than 300 offer graduate degrees in scientific, medical, and engineering subjects, and not enough of these can claim real distinction in any one scientific field. The few top-quality departments are in danger of becoming overloaded, and the peak in graduate enrollment is still several years off. It is especially important that we build more first-rate graduate schools of engineering and that they be developed in close association with excellent departments of science.

In the fall of 1958 there was a significant drop in the number of students entering engineering schools. This is serious, and it comes at a time when we must enroll more able students in engineering, not fewer. There is some evidence that students are shifting into the sciences, and so they are not lost to the broad fields of science and technology. But we need to try to find all the reasons why this reduction in enrollment has occurred, so that we may take measures to counter it and guarantee our future supply of outstanding engineers.

These five examples of the panel activities of the President's Science Advisory Committee, as you will note, fall outside of the defense area and bear testimony that the committee is deeply concerned with civilian science and technology and with the strength of science apart from any applications. At the same

time, the committee and my office are working hard on various problems important to defense. This will continue.

Controversy and Collaboration

We have also had to deal with the difficult problem of making technical evaluations in projects or programs on which there has been a history of technical controversy, or of differing interpretations of the technical facts by informed laymen. In dealing with these controversial problems, we have sought to recruit the most competent advisers available and to let them study these problems in an atmosphere as free as possible from past commitments or from personal or departmental positions. We have recognized that there are certain kinds of technical questions to which scientists and engineers of equivalent objectivity, competence, and complete integrity will respond differently. Here we have sought to state the facts and to list the possible alternative interpretations. It is important, as science gets involved more and more in controversial policy decisions, that the public should understand that scientific method and analysis do not always yield a single, mathematically exact, incontrovertible answer. It will help the relation of science to policy-making to have it recognized that the scientist, however objective, must sometimes be limited to dusty answers when policy-makers understandably are "hot for certainty." There are, of course, many questions, too, on which they can give positive and exact answers, the correctness of which can be demonstrated.

We have also given much thought to the problem of how the scientist and engineer may most effectively participate with military and political personnel in analyzing policy questions which must have the benefit of the joint thinking and professional competence of all these groups. The scientist and engineer have much to learn about their role under circumstances of this kind, but there have been recently heartening demonstrations of effective political-military-technical teamwork in support of the formulation of policy.

In any discussion of science and policy, we must recognize that these two areas—(i) the problem of dealing with evaluations and analyses with respect to technical matters in controversy and (ii) the way in which the scientist and engineer play their part in studies and confer-

ences requiring joint political, military, and technical approaches—call for the objective and creative attention of all three groups and afford the scientist and engineer a new and important kind of collaborative effort that symbolizes their widened role in the area of public policy.

In this summary report covering the work of the past year that has been directed toward strengthening our national science program and improving the relationship between science and policy, I must end by reiterating that we have much yet to accomplish. There is clearly now a national will to be strong in science, but much remains to be done. If the United States is to use to their fullest all its resources in science and technology, we must not slacken our efforts to provide the conditions and the climate which will promote peak performance.

And now may I conclude with four observations which seem to me to be important to any program designed for underwriting the strength of our science and technology.

The Factor of Excellence

First, the quality of our science and our science education cannot be separated out from the quality of our intellectual life generally. What we are concerned with basically is the importance which the American people give to the factor of excellence in our society. It is basically important that we achieve a greater respect for learning, a greater pride in intellectual achievement, a willingness to assign education a higher place in our national list of priorities. This requires that we be willing to increase our investment in men as well as our investments in material resources. In considering the effect of American attitudes and values on science and education, one cannot fail to ask whether we Americans, in our drive to make and acquire things, have not been giving too little attention to developing men and ideas. If we are to maintain leadership in this century of science, we must be sure that we devote an adequate amount of our energy and resources to the cultivation of talent and quality and intellectual accomplishment. These qualities are important to our national strength in all fields, and they are vital to our strength in science.

Should we not seek so to order our society that it will someday be said of

Americans, as it has been said of the ancient Greeks, that they were a people of "fine quality living in conditions which habituated them to high spiritual, mental, and physical endeavor"?

Our Tradition of Progress

My next observation relates to the motivations in our society which give vigor to our science and technology and which are important to our continuing strength. So far we have demonstrated a sustained eagerness to find better ways of doing things. We have forged ahead because we wanted things to change. We have wanted to look forward and not backward. The revolution of modern man—the revolution which has found its fullest expression here in the United States—lies essentially in this. It is a revolt against things as they are when there are ways of doing things better. It is a revolution based upon determination rather than determinism. It is a revolution against all the forces which hinder man in building a better life. Science has had a major part to play in shaping this basic American faith in creative change and improvement.

The course of our nation has been deeply affected by the tenet, very early embraced, that nature could be put to work for the benefit of man and that it is possible to wrest from nature a range of benefits to meet the needs of our people—that science and technology provide a means to advance the welfare of our people and that this has been a better way to progress than through radical social change or ideological nostrums.

I do not suggest that we have any warranty, expressed or implied, that progress is inevitable or immutable; I only describe the deep-rooted American belief that progress is an achievable and worthy goal. I reflect my own intuitive belief that man has the capacity greatly to improve himself and his society.

Today we hear voices of doubt and pessimism, decrying or questioning the concept of progress. The increased currency of such phrases as the "illusion of progress" and the "corrosive effect of materialism" reflect an array of attitudes challenging the power of reason and the actuality of progress. Technology and science are attacked as contributing only to the convenience and comfort of life and not to its quality. In mentioning this attitude of doubt and pessimism, it is not my purpose to debate the philosophical

considerations on which they rest. My purpose is to express my contrasting faith that we can continue to draw the blueprints of a still greater society and that we can direct our advancing technology toward the realization of those plans. My purpose is to stress the importance of those aspects of science which enhance the quality of our society, which encourage individuality in the midst of standardization, which enhance man's excellence and dignity as well as his productivity. We must direct and expand our technology to serve man's highest capabilities, in addition to his safety and material comfort.

If research is to continue to flourish, these traditional American beliefs in the validity of progress become increasingly important. They are the wellsprings of that zest and audacity which have characterized our research and our economy in the past and, God willing, will continue to characterize them in the future.

National Responsibility

My third observation has to do with the great responsibility which rests upon science today in the light of the extraordinary opportunities to participate in the formulation of national policy which

it has been given. The growing linkage of science and technology with government demands of science a new order of poise, steadiness, and statesmanship. It demands of scientists who serve in advisory capacities a deep understanding of the role and the limitation of the adviser.

The current emphasis on science, if it is not to cause reactions adverse to science, also requires of the scientific community humility and a sense of proportion. It requires of scientists a recognition that science is but one of the great disciplines vital to our society and worthy of first-rate minds—a recognition that science is a partner, sharing and shouldering equally the responsibilities which vest in the great array of professions which provide the intellectual and cultural strength of our society.

Science and Human Values

Fourth and finally, I recall the remarks which I made in giving the Sigma Xi address at the AAAS meeting three years ago. I emphasized then, as I do again, that if American science is to continue to prosper, if it is to attract to it its proper complement of creative and gifted minds, we must combat the notions that

science and engineering are incompatible with the great humanities, and that they are narrowly materialistic and destructive of human values. In the face of the practical responsibilities which rest in science and engineering for our security and our material welfare, it is all too easy for people to conclude that science is inimical to the spiritual ends of life and for them to fail to understand that in reality it is one of man's most powerful and noble means for searching out truth and for augmenting man's dignity by augmenting his understanding. Scientists have an obligation to make this true character of science better understood, not by an arrogant advocacy of science and technology as the only objective means to increase our understanding and well-being, but by the balanced and tolerant practice and presentation of science as one of the powerful means by which man can increase his knowledge and understanding and still remain humble and ennobled before the wonder and the majesty of what he does not understand. When thus perceived and practiced, and when not misused for ignoble ends, science and engineering are major means for "making gentle the life of mankind." When so practiced and used, they become one of the great humanistic forces of our time.

News of Science

AAAS Council Resolutions

The Council of the AAAS passed the following resolutions on 30 December 1958, when it met in Washington, D.C., during the Association's annual meeting, 26-31 December.

Resolution on Parliament of Science. The Council commends the Board and the special committee which arranged the stimulating Parliament of Science in Washington in March, 1958, pursuant to the Council's resolution in 1957, and notes with gratification that plans for further symposia are already well advanced.

Resolution on Committees on the Social Aspects of Science. The Council

commends the accomplishments of the ad hoc committees on the Social Aspects of Science. They have had significant and beneficial effects on the understanding by scientists and by the public of the inescapable problems of adapting society to the age of science.

The Council has approved the Board's proposals to create standing committees to continue work in this area and will take special interest in their activities.

In order that the Council members and the affiliated societies may be kept fully informed of the thinking of these committees, as well as of formal Board actions resulting from their recommendations, the Council requests that the President arrange for the circulation to

Council members of the special report of the Committee on the Social Aspects of Science issued after their June, 1958, meeting and of future reports of the three standing committees.

Resolution on International Scientific Programs. The success of the International Geophysical Year in correlating and integrating international scientific resources and extending the areas of co-operation and communication in science stands as a challenge to all other areas of scientific and cultural endeavor. This magnificent international effort is a fitting prelude to the "space age." The time is now ripe for world-wide attacks on other major problems.

The Council of the American Association for the Advancement of Science urges its affiliated societies, the Board of Directors, and appropriate committees to participate fully in appropriate international programs, for example, in such areas as the health sciences, outer space exploration, population problems, and social consequences of science.

Resolution on Dissemination of Council Resolutions. The Council requests the President to send duplicate copies of resolutions passed at this meeting to each

Council member, with the suggestion that these be submitted, if appropriate, to the Affiliated Societies for consideration along with an indication of action being taken to implement the resolutions, and with a reminder that Council members may submit appropriate resolutions originating in the Affiliated Societies for consideration by the Council or Board.

Resolution on Agenda and Resolutions Committee for 1959. Pending the report of the Committee on Council Activities and Organization, the Council requests the President to appoint a Special Committee on Council Agenda and Resolutions for 1959.

Resolution on International Travel and Communication. As indicated in the Report of the 1958 Parliament of Science, "the pursuit of knowledge is an activity of the human race, not an activity of political subdivisions." History has shown that our country has gained greatly from the visits and collaboration of scientists from other countries.

The Council of the American Association for the Advancement of Science notes with gratification that the changes in the U.S. passport regulations have improved international communication in science.

It is hoped that the issuance of visas and credentials may be further facilitated so as to permit the unimpeded travel of scientists throughout the world.

Resolution on Control of Nuclear Weapons Test. In the more than ten years of world-wide concern about the control of nuclear weapons and the exposure of human populations to increasing levels of radioactivity, scientists have carried a multiple responsibility. As scientists, it has been—and remains—our task to maintain the traditional devotion of scientific knowledge to the advancement of human welfare. This requires that the unprecedented power of nuclear energy be used for creative rather than destructive purposes. It is also our responsibility, through continuing scientific study, to extend our knowledge of the effects of radiation, including that from nuclear explosions, on human populations, and to explore techniques for nuclear controls. The reports of the United Nations Radiation Committee and the Radiation Committees of the National Academy of Sciences, which evaluate the known biological effects of radioactive exposure, and which recommend that all such exposures be kept at the lowest possible levels, represent major scientific contributions to the solution of this urgent problem.

It is our further task to help in the transmission and translation of this knowledge to the public, for the final and effective decisions on nuclear energy control must be made not by scientists alone, nor by the military, but by all citizens—

and only an informed public can decide wisely.

The arena of decision now has moved to Geneva, where representatives of those nations which possess nuclear weapons are attempting to negotiate an international system to suspend the further explosions of such weapons. We believe that these negotiations represent a bright hope for the translation of scientific knowledge into effective public policy on a question which—literally—involves the survival of civilization. As both scientists and citizens, we have a deep concern with the success of the Geneva negotiations.

BE IT RESOLVED, therefore, that the Council of the American Association for the Advancement of Science express its profound hope that the Geneva Conference negotiations will prove successful.

The Council requests the President of the Association to transmit the sense of this resolution to the Geneva Conference through appropriate channels.

Resolution on Federal Aid to Education. The Council of the American Association for the Advancement of Science welcomes the National Defense Education Act of 1958 as further confirmation of the principle that the Federal Government should share in the responsibility for the support of education.

AAAS Annual Meeting Awards

The following awards were presented during the annual AAAS meeting, which took place in Washington, D.C., 26–31 December.

Newcomb Cleveland Prize. Jerzy Neyman and Elizabeth L. Scott of the Statistical Laboratory, University of California, Berkeley, received the 31st AAAS Newcomb Cleveland Prize for a paper entitled "On Certain Stochastic Models of Population Dynamics." This \$1000 award is given annually by the Association to the author or authors of a noteworthy paper presented on a regular program of the meeting and representing an outstanding contribution to science.

A stochastic model of a natural phenomenon means a system of mathematically expressed hypotheses representing the given phenomenon as a particular combination of several "elementary" chance mechanisms, such as tossing a coin or drawing a ball out of a bag. With reference to biological phenomena, the credit for the hypotheses underlying the model belongs to biologists. The role of the mathematicians is limited to expressing these hypotheses in a mathematical form and to deducing verifiable consequences. The value of a model found to be consistent with a number of the manifestations of the phenomenon is partly

esthetic and partly utilitarian, due to the possibility of predicting important manifestations which, momentarily, are difficult to observe.

The paper discusses three specific models with which the authors have been concerned: struggle for existence, phenomenon of clustering of populations, and carcinogenesis.

Theobald Smith Award. Albert Sjoerdsma, head of the experimental Therapeutics Section of the Laboratory of General Medicine and Experimental Therapeutics of the National Heart Institute, Bethesda, Md., received the Association's fourteenth Theobald Smith Award in Medical Sciences for his research on amines. The award, which is supported by Eli Lilly and Company, consists of \$1000, a bronze medal, all travel expenses to and from the meeting, and all expenses at the meeting for its duration. It is given for "demonstrated research in the field of medical sciences, taking into consideration independence of thought and originality." The recipient must be less than 35 years of age as of 1 January of the year in which the award is made, and must be a U.S. citizen.

Sjoerdsma's interest in amines focused early on the new vaso-active amine, serotonin, prompting him to study the metabolism of patients with malignant carcinoid, a tumor of intestinal serotonin-producing tissues, the physiologic activity of which was virtually unknown before 1954. Since 1954 his studies of the serotonin metabolism of carcinoid patients have disclosed much of what is known about the role of serotonin overproduction in the symptoms of this tumor. Sjoerdsma's application to carcinoid patients of a chemical test (which he helped develop) for the urinary serotonin metabolite, 5-HIAA, has now established this ingenious test as the method for diagnosing the malignant carcinoid. This previously almost unknown tumor has consequently been found to be relatively common.

His studies of pheochromocytoma, another tumor which produces adrenalin and other catechol amines, have demonstrated in man much of the biochemistry of adrenalin metabolism which had previously been known solely from studies in animals.

His clinical and experimental studies on the amines in mast cell tumors demonstrated for the first time that serotonin is not secreted by human mast cells, as was previously believed from studies in animals. The work with the malignant carcinoid, pheochromocytoma, and mast cell tumors has made Sjoerdsma an authority on "secreting" tumors.

Another clinically important facet of his contribution to medical understanding of amine metabolism has resulted



Paul E. Klopsteg, president of the AAAS, presents the AAAS-Campbell Award to Karl Maramorosch of the Rockefeller Institute, while L. P. Reitz, chairman of the award committee, looks on. [Courtesy Chase, Ltd., Washington, D.C.]

from his work with compounds which inhibit monoamine oxidase, the enzyme primarily responsible for destroying amines in the body. The findings of Sjoerdsma and his colleagues have shown that these enzyme-inhibiting compounds—particularly ipronazid and JB-516—are capable of producing marked and sustained lowering of blood pressure in hypertensive patients. Thus the biochemical and pharmacologic studies of monoamine oxidase inhibition apparently have led to the opening of a new approach to the treatment of hypertension.

Sjoerdsma has now received a special National Institutes of Health Traineeship to work with Professor Jan Waldenström, University of Lund, Malmö, Sweden, beginning 1 June 1959.

Rosenthal Award. Harry Rubin, associate professor of virology, University of California, Berkeley, received the AAAS-Anne Frankel Rosenthal Memorial Award for Cancer Research. This \$1000 award is provided by the Richard and Hinda Rosenthal Foundation and was given for the fourth time at the recent meeting.

Rubin has a basic interest in host-virus relationships. During the past several years, his research has centered on the interaction of Rous sarcoma virus and susceptible cells. Prior to the initiation of his studies in this area, investigators had worked on the problem only at the level of the whole tumor and the whole animal. Rubin, however, was interested in the virus-cell relationship at the level of the individual cell.

As a result of his inquiries, both at the California Institute of Technology in collaboration with graduate student Howard Temin and at the University of California, Rubin succeeded in developing a

practical, precise, and reproducible technique for assaying in tissue culture both the amount of virus and the number of Rous sarcoma cells present. The development of this assay technique has permitted a variety of experiments that have revealed several types of important new information on the cell-virus relationship. For the first time in virus work, it was clearly demonstrated by Rubin and Temin that an infected cell could produce virus and continue to divide. This characteristic distinguishes tumor viruses from all other viruses thus far investigated.

In addition, Rubin was able to prove that a single infectious unit of Rous sarcoma virus is adequate to initiate a tumor. The virus was shown to be capable of causing either an ectodermal or mesodermal tumor in the chick embryo with equal efficiency, depending only on the type of cell infected. This was in contrast to the accepted idea that a tumor virus is restricted to one type of tissue.

Rubin also demonstrated that the Rous sarcoma virus is produced at an extremely slow rate by infected cells and is released gradually and continuously by most, if not all, of the cells derived from the tumor.

Rubin has shown, in tissue culture, that a single virus particle can infect and transform a normal cell into a malignant cell. His findings further suggest that the genetic material of the virus must be integrated with that of the cell before production of the virus and formation of the tumor can begin.

Gould Award. Robert F. Rushmer, professor in the department of physiology and biophysics, School of Medicine, University of Washington, Seattle, received the third AAAS-Ida B. Gould

Memorial Award for Research on Cardiovascular Problems. This \$1000 prize is supported by the Richard and Hinda Rosenthal Foundation. Rushmer was honored for developing new methods of recording heart function.

Rushmer was trained as a physician but became interested in research in problems of aviation medicine during World War II. He learned to fly and conducted research on many subjects, including "blackout." These studies required the development of new forms of instrumentation and led to a continuing interest in the application of modern technical advances to the study of function and control of the heart and blood vessels.

Most of the theories about heart function were derived from investigations on experimental animals under anesthesia. In general, anesthetics and experimental procedures depress the nervous system and distort the control mechanisms so that the heart function is highly abnormal. During the past decade, Rushmer and a group of colleagues skilled in different specialties have pioneered new methods of recording the function of the heart in intact experimental animals for long periods of time without inflicting pain or discomfort. For example, the new developments in recording techniques and electronic computers provide continuous records on moving paper of eight different characteristics of the main pumping chamber of the heart. These records constitute a veritable engineering-type analysis of the changes in the heart's performance while an experimental animal is walking, running, eating, or sleeping. A group of surgeons practicing in the community has collaborated for more than 10 years to develop painless procedures for implanting miniaturized measuring instruments. Days or weeks later, measurements are made without discomfort to the animal and with minimal interference with function. Such studies are essential to determine the importance of the brain and nervous reflexes in regulating the performance of the heart.

Campbell Award. The AAAS-Campbell Award for Vegetable Research, established last year by the Campbell Soup Company, was given to Karl Maramorosch of the Rockefeller Institute for Medical Research, New York. The award consists of \$1500 and a bronze medal given for "an outstanding single research contribution, of either fundamental or practical significance, relative to the production of vegetables, including mushrooms, for processing purposes, in the fields of horticulture, genetics, soil science, plant physiology, entomology, plant pathology, or other appropriate scientific areas."

Maramorosch was honored for his paper on "Cross Protection Between

Two Strains of Corn Stunt Virus in an Insect Vector" that appeared last October in *Virology*. This report, however, simply happens to be the most recent from Maramorosch's series of studies on viruses, virus diseases, and virus transmission. In fact, he has written 56 other papers on these interrelated problems.

Corn stunt disease was described for the first time in 1945, when it appeared in California and Texas. A leafhopper is a vector of the causative virus. The corn stunt virus requires a very long incubation period in the maize plant and in the insect vector. It can be transmitted mechanically from insect to insect but not from plant to plant. It can be maintained in serial passages in the leafhopper. The disease is of greater economic importance in Mexico than in the United States. In a field investigation carried out in 1955, the occurrence of two strains of corn stunt virus was noticed in Mexico. Subsequent tests were carried out to investigate the interrelationships between the two causative strains of stunt virus.

For many years cross-protection tests have been used as a routine method for determining strain interrelationships of plant viruses. Two strains of corn stunt virus, designated as Rio Grande (R.G.) and Mesa Central (M.C.) are easily distinguishable in infected sweet corn plants on the basis of differences in leaf discoloration. They were therefore chosen for a study of possible strain interference in vectors. Maramorosch had previously shown that in the case of aster yellows, plant viruses multiply in their insect vectors. He established this for sweet corn stunt viruses also.

The experiments for his prize-winning work demonstrated that interrelationships between strains of viruses in arthropod transmitters may not become apparent unless the acquisition feeding periods are adequately long or adequately spaced. Protection by R.G. virus against the M.G. strain was rendered detectable only after R.G. virus was given adequate time to become well established in the insect host.

These results confirm Kunkel's original discovery that a plant virus that multiplies in its insect vector may protect this vector against infection by a related strain of virus. Whenever the strains of aster yellows virus had adequate opportunity to become established in the vector, cross-protection was complete. The relationships of R.G. and M.C. strains of corn virus, revealed by the present tests, seem to represent the first instance of a unilateral protection by a plant virus in an insect vector.

Industrial Science Award. The Westinghouse Electric Corporation won the AAAS Industrial Science Achievement Award, which is administered by Section P—Industrial Science. The company was honored for developing a machine called



An early version of Opcon "mans" one of the test stations on the capacitor production line at the Westinghouse switchgear plant in Bloomington, Ind.

Opcon (for "optimizing control") that is based upon a new concept in control systems; it replaces the pre-set, routine functions performed by a conventional system with the humanlike process of reaching a logical conclusion through experiment. The machine discovers for itself the difference between right and wrong decisions and makes impartial judgments based upon its own experience.

The idea of replacing the human function in control was first undertaken as a theoretical study at the Westinghouse Research Laboratories. About 2 years ago research mathematician, Robert Hooke, developed the required mathematical logic, which was demonstrated experimentally in a device called Automex (for "automatic experimenter"). The logic first was translated into functional apparatus under the guidance of R. E. Wendt of the Westinghouse Headquarters Manufacturing Laboratory. Then, under the direction of W. G. Evans, improved full-scale systems were developed by the company's New Products Engineering Department.

An Opcon optimizing control now is automatically performing a test on the entire output of capacitors in a new Westinghouse plant in Bloomington, Ind. For the past several months, a more-advanced version has been installed on a dehydrogenation miniplant of the Dow Chemical Company in Midland, Mich. This Opcon unit has successfully performed the difficult task of experimentally operating the miniplant at chosen optimum conditions and has good potential for full-scale plant operation. Another Opcon system is being built to run

a complete distillation column in a refinery of the Sun Oil Company in Marcus Hook, Pa.

Other Prizes. Other prizes, not under AAAS sponsorship, were awarded during the Association's annual meeting.

Guy Suits, vice president and director of research, General Electric Company, received the William Proctor Prize for Scientific Achievement, which is awarded annually by the Scientific Research Society of America. It was presented at a luncheon meeting of Section X—Science in General.

John F. Fulton, Sterling professor of the history of medicine at Yale University, and for many years chairman of Yale's physiology department, received the Sarton Medal of the History of Science Society. The award, which is supported by Chas. Pfizer and Company, was presented at a joint dinner meeting of Section L—History and Philosophy of Science and of the History of Science Society.

Renato Dulbecco, professor of biochemistry at California Institute of Technology, received the John Scott Award of the Board of City Trusts of Philadelphia, for his development of a method for demonstrating the presence of viruses in tissues. His method provided a technique for the production of plaques with animal cells. The award was presented during a dinner meeting of Section F—Zoological Sciences.

AEC and Euratom Invite Joint Research Proposals

The United States Atomic Energy Commission and the Commission of the European Atomic Energy Community have announced that they are prepared to receive proposals for research and development centered on nuclear power reactors to be built under the joint U.S.—Euratom program. This research and development program is an integral part of the joint program contemplated by the Agreement for Cooperation between the U.S. and Euratom signed in Brussels in November 1958. The over-all industrial objective is the installation within the next 5 to 7 years in the Euratom Community of U.S.-type power reactors that will have a total electrical generating capacity of approximately 1 million kilowatts.

While the agreement will enter into force only upon completion of statutory requirements in the United States and Euratom, proposals are being solicited at this time in order to expedite the process of review and evaluation so that the research and development program can be initiated promptly upon the effective date of the agreement. It is hoped that the agreement will become effective early in 1959.

Proposals may be submitted by any person, institution, corporation, or group in the United States or in the Euratom countries, or by groups including both U.S. and Euratom representation. The association of European and American personnel in the research and development projects is encouraged. Proposals may cover work in any field which the proposer considers relevant to the objectives of the joint program.

To implement the research and development program, the AEC and Euratom have created a Joint Research and Development Board. Among the functions of the Joint Board are the receipt, evaluation, and selection of proposals and over-all technical guidance of the work contracted for. Proposals may be submitted at any time and will be evaluated upon receipt. Further details concerning the joint research and development program may be obtained by writing to: Euratom-U.S. Joint Research and Development Board, 51 Rue Belliard, Brussels, Belgium, or Director, Division of International Affairs, U.S. Atomic Energy Commission, Washington 25, D.C., U.S.A.

Geophysics Journal

The American Geophysical Union has announced the establishment of a monthly *Journal of Geophysical Research*, with the first issue scheduled to appear this month. The publication, which will be partly supported by the National Science Foundation, will carry original scientific contributions on the physics of the earth and its environment and is specially designed to meet the challenge of the expansion in research activities brought about by the International Geophysical Year.

The new journal arises out of a combination of two periodicals—the bi-monthly, *Transactions of the American Geophysical Union*, and the quarterly, *Journal of Geophysical Research*. Editors of the monthly are Philip H. Abelson, director of the Geophysical Laboratory, Carnegie Institution of Washington, and James A. Peoples, Jr., of the geology department, University of Kansas. Editorial offices are at Lawrence, Kan.

Soviet Research Information Wanted

The Center for International Studies of the Massachusetts Institute of Technology is conducting a study of scientific research and development expenditures and manpower in the U.S.S.R. for the National Science Foundation. Alexander Korol, author of *Soviet Education for Science and Technology*, is serving as principal investigator. Concerned pri-

marily with selected fields of the natural sciences, the study will include an analysis of how the Soviets allocate economic and manpower resources to various fields or research and development. Data will be compiled on a basis as comparable as possible with similar data for the United States.

To make the study as accurate and complete as possible, the foundation invites communications from scientists who have visited Soviet laboratories and from specialists in the Soviet field interested in this problem. Reference to significant published studies and those now in progress in the United States or elsewhere will be appreciated. Also desired are unpublished memoranda and reports, which will be returned if requested. Communications should be addressed to Dr. Jacob Perlman, Head, Office of Special Studies, National Science Foundation, Washington 25, D.C.

News Briefs

Seven Norwegian scientists from the Norwegian Defense Research Establishment spent 7 weeks at the Navy base in Key West, Fla., testing a new antisubmarine weapon system called the *Terne* (Tern). The Norwegian frigate in which *Terne* is mounted was sent to Key West for the extensive trials which could not be made in Norway. After completing their work at Key West, the group toured naval laboratories. Part of the exchange of information between NATO countries, the tour enabled the scientists to learn more about the underwater ordnance program.

The National Aeronautics and Space Administration has selected Rocketdyne, a division of North American Aviation, Inc., Canoga Park, Calif., as the source for design and development of a rocket engine in the 1 to 1½ million-pound thrust class.

A gift of 25,000 reprints of scientific articles has been given to the Howard College library at Birmingham, Ala., by Emmett B. Carmichael, professor of biochemistry at the University of Alabama Medical Center. Representing his 40-year collection on experimental medicine, including bio- and general chemistry, physiology, and pharmacology, it has more than 600 reprints on cancer research alone. One of the chief values of the collection is that approximately 13,000 of the pamphlets are already cross-indexed.

A new sheep disease, enterotoxemia type A, has been found in California. Blaine McGowan of the University of California's School of Veterinary Medicine, Davis, has so identified a disease

that caused the death of about 100 suckling lambs on six California ranches during the spring of 1958. Five of the ranches were in the Sacramento Valley and one was in the Coast Range. The same bacterial disease was found in Australia in 1936 but has not been reported in the United States until now.

Misericordia Hospital, Philadelphia, Pa., recently opened a new animal research laboratory in a separate building on the hospital grounds. A research program has been started, with the aid of various grants, by Ward D. O'Sullivan, director of the department of surgery; William C. Foster, director of the laboratory of clinical chemistry; and Jules Rominger, associate radiologist.

The Pergamon Press will publish, in 14 volumes, the transactions of the fourth International Biochemistry Congress, Vienna, September 1958. These transactions, which are to appear early next year, represent all the symposia and colloquia contributions, with the discussion and the proceedings of the plenary sessions. The papers presented at the Vienna conference provide a cross-section of the present state of knowledge throughout the broad field of biochemistry.

A prefabricated atomic reactor has been assembled at the California Institute of Technology. It is to be used in a nuclear engineering laboratory to train mechanical engineers. The new student reactor, built and designed by Nuclear-Chicago Corporation, requires only about 3 days to assemble and load with fuel. The assembly is designed so that it cannot reach criticality; this makes a nuclear accident impossible.

North Rhine-Westphalia is the first province in the Federal Republic of Germany to inaugurate free treatment of cancer for everyone. There are already 180 municipal-examination centers in North Rhine-Westphalia. The expense to the state of each case treated, including care of the person's family where necessary, is estimated to be about DM30,000.

The Air Force has selected Sundance, Wyo., as the site for the installation and test operation of a factory-assembled, modular nuclear power plant for use in remote military installations.

A metallurgical research center for Olin Mathieson Chemical Corporation which combines laboratories and pilot production plant will be completed in New Haven, Conn., by mid-1959. The new \$4-million center will be organized into two primary units—the Metals Research Laboratories, and the Nuclear

Fuel Research Laboratories. The latter will not only serve the corporation but will also do contract work for private industry and government agencies.

* * *

Irvington House and New York University have signed a joint agreement to establish the Irvington House Institute for Rheumatic Fever and Allied Diseases as a part of NYU-Bellevue Medical Center. The institute will be housed in the new University Hospital. Irvington House will underwrite the cost of \$500,000 toward the construction of the treatment, research, and clinical facilities. Irvington House, at Irvington-on-Hudson, N.Y., is a hospital and research center for children afflicted with heart diseases. The establishment of the institute will create what is believed to be the largest research center of its type in the world.

* * *

A dry-land "ocean" that duplicates the environment found two nautical miles deep in the sea is under construction at Chester, N.J., by the Bell Telephone Laboratories for long-term testing of underwater cables. The simulated ocean, an 8-foot wide concrete trough, is 315 feet long and buried 7 feet under the ground. This assures reasonably constant earth temperatures the year round. The trough will be filled with water maintained at an ocean-bottom temperature of 37°F.

Grants, Fellowships, and Awards

Arctic. McGill University, Montreal, Canada, has announced the Carnegie Arctic Scholarships. Under a program supported financially by the Carnegie Corporation of New York, certain scholarships are offered to students possessing a bachelor's or master's degree or equivalent. These scholarships are tenable at McGill and are normally offered to students proceeding to a doctoral degree in a subject calling for active field research in Arctic or Subarctic North America. Candidates who do not intend to proceed to a degree are not necessarily disqualified. Such subjects as anthropology, bacteriology, botany, geography (including glaciology and meteorology), geology, genetics, parasitology, psychiatry, sociology, and zoology (including marine biology) will be considered, and successful candidates will be enrolled in one of these departments.

The scholarships are normally tenable for 1 year and renewable for a second year. Ordinarily they provide \$1500 for the academic session, and \$1250 for the expenses of a summer's field expedition. If renewed for a second session the scholarships are increased to about \$1750.

Applications should be submitted to

the Secretary of the Carnegie Arctic Program, McGill University, 539 Pine Ave. W., Montreal, P.Q., Canada, and should include a confidential recommendation of the candidate's qualifications in his or her selected field and a clear statement of the intended arctic or subarctic research project. No particular form is required when applying for these scholarships. Applications for session 1959-60 must reach Montreal by 1 March 1959.

Educational testing. The Educational Testing Service, Princeton, N.J., will offer two visiting associateships in test development for the summer of 1959, one in mathematics and one in science. The associateships will give experienced teachers an opportunity to study testing problems in relation to goals of instruction. The stipend will be \$700 and reimbursement for transportation to and from Princeton. Both associates will make critical analyses of existing test specifications and test questions, suggest improvements, and work on the preparation of new tests. They will work on tests at the college-entrance and higher levels.

The visiting associate in science should have a strong background in chemistry, physics, or biology. Training in more than one of these sciences is desirable. The associate should have four or more years of teaching experience in college or in secondary school, or in the two combined. The visiting associate in mathematics should have a strong background in modern mathematics. Four or more years of college teaching experience is required. Applications must be submitted by 27 February 1959. Requests for application forms and all inquiries should be addressed to: Mrs. W. Stanley Brown, Test Development Division, Educational Testing Service, 20 Nassau St., Princeton, N.J.

Meteorology. The University Committee on Atmospheric Research has announced the establishment of ten fellowships for graduate study in the atmospheric sciences. These fellowships are made possible by a grant from the Alfred P. Sloan Foundation, Inc., of New York City. The fellowships carry a stipend of \$4000 each and will be awarded for the 1959-60 academic year. The fellowships are tenable at any accredited institution that offers a graduate program in the physical sciences of the atmosphere—meteorology and closely related fields. Applicants should have a baccalaureate degree (or expect to receive their degree by August 1959) with a major in one of the physical sciences, meteorology, geophysics, mathematics, or engineering. Applications must be received by 28 February. Application forms and further information may be obtained from the University Committee on Atmospheric Research, P.O. Box 3297 MSS, Tallahassee, Fla.

Scientists in the News

DON K. PRICE, dean of the Graduate School of Public Administration, Harvard University, and former vice president of the Ford Foundation, has been elected to the AAAS Board of Directors, effective 15 January. He will complete the term of Chauncey D. Leake, who has been voted president-elect of the Association.

MAURICE BENDER, assistant chief, standards inspection and certification unit, U.S. Bureau of Commercial Fisheries, has joined the Division of General Medical Sciences at the National Institutes of Health as a public health research program analyst. He will be concerned with the administration of the research grant program of the division.

AMOZ I. CHERNOFF, formerly associate professor of medicine at the Duke University School of Medicine and chief of the hematology section, Veterans Administration Hospital, Durham, N.C., has joined the staff of the University of Tennessee Memorial Research Center as research professor.

DAN YUN LEE, formerly an electronic design engineer at the University of California Radiation Laboratory, Livermore, has recently joined the Systems Engineering Program, Nucleonics Division, U.S. Naval Radiological Defense Laboratory, San Francisco, Calif.

HENRY KRITZLER, resident naturalist, has left the Fort Johnson Marine Biological Laboratory, Charleston, S.C., to be resident naturalist of the Lerner Marine Laboratory, Bimini, Bahamas, British West Indies.

At the Harvard School of Dental Medicine, **JAMES T. IRVING** has been appointed professor of anatomy and **ALEXANDER C. KERR** has been named associate in physiology in the Forsyth Dental Infirmary. Irving joins Harvard from the University of the Witwatersrand, Johannesburg, Union of South Africa, where since 1954 he has been professor of experimental odontology and director of the Joint Dental Research Unit of the Council for Scientific and Industrial Research. Kerr has served for the past 2 years as honorary junior lecturer in physiology at Guy's Hospital, London, England.

WILLIAM K. LINVILL, project leader for the Institute for Defense Analysis, Washington, D.C., has joined the staff of the Rand Corporation, Santa Monica, Calif., where he will serve as a member of the senior staff of the Engineering Division's electronics department. From 1947 to 1956, Linvill was

associate professor of electrical engineering at Massachusetts Institute of Technology.

LAWRENCE E. BRENNAN has also joined the senior staff of the Rand electronics department. Since November 1956 he had served as a member of the senior systems staff with the Systems Laboratories Corporation in Sherman Oaks, from which he was on loan to the Office of Naval Research, Washington, D.C., as a consultant on the Marine Air Defense Project.

OTTO STRUVE, chairman of the department of astronomy at the University of California, Berkeley, has been elected a corresponding member of the French Academy of Sciences in Paris.

HERBERT J. MUELLER, formerly a physicist at the University of Vienna, Vienna, Austria, has joined the staff of the Basic Research Group at the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va. He will serve as assistant chief of the Group, which makes laboratory determinations of general, special, and chemical properties of selected metastable substances in the solid, liquid, and gaseous states. The Group also determines the influence of controlled electric magnetic, electromagnetic, and particle field conditions on these properties.

JOHN C. BAILAR, Jr., professor of inorganic chemistry at the University of Illinois, took office on 1 January as president of the American Chemical Society. He succeeds CLIFFORD F. RASSWEILER, vice president for research and development of the Johns-Manville Corporation, New York. The new ACS president is widely known for his contributions to chemical education and to inorganic chemistry.

ARNOLD V. WOLF, chief of the renal section of the department of cardiorespiratory diseases at the Walter Reed Army Institute of Research in Washington, D.C., has been appointed head of the department of physiology, University of Illinois College of Medicine. He succeeds GEORGE E. WAKERLIN, who resigned last April to become medical director of the American Heart Association. Wolf is noted for his research in the physiology of thirst and in artificial kidneys.

FRANK C. HAPPOLD, professor of biochemistry and chairman of the department, Medical School, University of Leeds, England, is serving until April as visiting research professor in the department of bacteriology, University of Florida. He is participating in research on tryptophane metabolism of marine bacteria and in various graduate activi-

ties. During his stay in the United States he will be visiting other institutions, including the University of Pennsylvania and Rutgers University.

ROBERT L. BLACKWELL was appointed director of the U.S. Sheep Experiment Station and Western Sheep Breeding Laboratory, Dubois, Idaho, effective 5 January. He succeeds JULIUS E. NORDBY, who retired recently. Blackwell has been an associate professor of animal husbandry at New Mexico Agricultural and Mechanical College, where his research has been in animal breeding with sheep and beef cattle.

MERVIN J. KELLY, chairman of the board of Bell Telephone Laboratories, has been named by the National Security Industrial Association to receive its 1958 James Forrestal Memorial Award. Kelly will deliver an address at the NSIA Forrestal Dinner on 29 January at the Sheraton-Park Hotel, Washington, D.C., when he will receive a gold medal and citation. In World War II Bell Laboratories was converted almost completely to military research and development and carried out more than 1200 projects for the Armed Forces.

FRANK M. CARPENTER, chairman of the biology department at Harvard University, is the new president of Sigma Xi, national scientific honorary fraternity. Carpenter is an entomologist whose studies on the comparative structure of living and fossil insects has helped to reconstruct the past 250 million years of insect life. He is curator of fossil insects at Harvard's Museum of Comparative Zoology.

ALLISON K. SIMONS, director of engineering and research for the Bostrom Corporation of Milwaukee, Wis., has received the national gold medal award of Pi Tau Sigma, honorary engineering society, for the most outstanding achievement in mechanical engineering within 10 years of graduation. The award was presented on 4 December in conjunction with the annual meeting of the American Society of Mechanical Engineers. Simons has specialized in the man-machine relationships affecting the comfortable, stress-free seating of drivers of trucks, tractors, and earth-moving equipment. With A. H. Easton of the University of Wisconsin, Simons developed electronic instrumentation that permitted the study of vibration and shock transmission to the human body through vehicular seating.

ELLISON C. SHUTE has been appointed manager of the Atomic Energy Commission's San Francisco Operations Office at Oakland, Calif. Shute, who has been deputy manager of the San Fran-

cisco office since January 1956, will succeed HAROLD A. FIDLER, who will accept a position as assistant to the director of the Ernest O. Lawrence Radiation Laboratory, University of California, Berkeley.

ALBERT L. ELDER, director of research of the Corn Products Company, Argo, Ill., and a specialist in medicinal chemicals, proteins, and starches, has been chosen president-elect of the ACS. He will head the society in 1960.

LAUCHLIN M. CURRIE has been elected a vice president of the Babcock & Wilcox Company and placed in charge of the Atomic Energy Division. To accept the new post, Currie retired as a vice president of the Union Carbide Nuclear Company, a division of the Union Carbide Corporation.

Recent Deaths

HOWARD C. ARNOLD, Pittsburgh, Pa.; 67; engineer with the Federal Enameling and Stamping Company from 1934 until his retirement this year; ceramic engineer with various firms from 1919 to 1930; 27 Sept.

DAVID C. GRAHAME, London, England; 46; professor of chemistry at Amherst College, who was spending a year on a Guggenheim fellowship at the University of Bristol, England; instructor in chemistry at the University of California, Berkeley, before joining Amherst College in 1939; staff member of Massachusetts Institute of Technology's Radiation Laboratory in 1945; taught summer school at Harvard University in 1948; 11 Dec.

MARTIN S. MAIER, Lancaster, Pa.; 64; nuclear physicist and since 1949 head of the physics division, research and development department, U.S. Asbestos Division of Raybestos-Manhattan, Inc., Manheim, Pa.; was engaged in a study of radiation effects on asbestos and asbestos products at the time of his death; head of the physics department at Sterling College (Kansas), 1933-39; research assistant with the Battelle Institute, Columbus, Ohio, 1940-44; and a senior physicist with Eastman Kodak Company, Rochester, N.Y., 1944-49; 23 Dec.

WILLIAM SCHRIEVER, Norman, Okla.; 64; professor of physics at the University of Oklahoma and chairman of the physics department, 1942-52; had been a faculty member since 1919; first president of Sigma Xi at the university; 20 Nov.

PERCY H. WILLIAMS, New York, N.Y.; 83; gynecologist and obstetrician; chief of staff at Lenox Hill Hospital, 1927-45; director of gynecology at Lincoln Hospital, 1924-34; 31 Dec.

Book Reviews

Verbal Behavior. B. F. Skinner. Appleton-Century-Crofts, New York, 1957. x + 478 pp. \$5.50.

This important book examines complex verbal behavior with an objective, functional, or causal analysis that has no use for "ideas," "images," or "meanings."

The basic model for language production is a simple one and is derived from the author's extensive investigation of the operant conditioning of infrahuman organisms. The pecking of a pigeon is an *operant* (it operates on the environment), and its rate and pattern of occurrence can be brought under the control of various stimuli—kind and schedule of reinforcement, drive states, colored lights, and so forth. The question for the present analysis, simply put, is: What determines the strength—simple occurrence, frequency, energy level, and so forth—of particular kinds of verbal behavior?

The *verbal operant* becomes the dependent variable in this account and is set apart in that its reinforcement is socially rather than mechanically mediated. The system is, in short, a taxonomy of the controlling variables and controlling relations for verbal operants. Several kinds of verbal operants are distinguished, but they must be defined not by their form but by their controlling variables and controlling relations. A most important type he has called the *mand*, a term with a certain mnemonic value for demands ("Let me go!"), requests ("Be a good fellow and get me a drink"), and so forth. Mands are specific to their reinforcement and are under the control of deprivation or aversive stimuli. Other verbal operants—*echoic*, *textual*, and *intra-verbal*—are under the control of verbal stimuli. The *tact* is the most important of verbal operants, and its capacity for "naming," "announcing," or "describing" has been the exclusive concern of many traditional formulations. In contrast to the *mand*, reinforcement is not specific to the response: It may be a nod, a warm smile, or even a softly voiced "ummmh." It is by generalizing the reinforcement that control comes to be concentrated in the stimulus object or some property of that object. *Audiences* constitute an obvious kind of control over style, tone, topic, and so forth. The basic

model is extended and gains generality in chapters on multiple causation, supplementary stimulation, and combining of fragmentary responses.

Skinner's approach to language is not one that gains a degree of success from excessively modest aims. He has accepted the challenge of ordinary conversation, composition, self-editing, and even scientific discourse. His discussions of metaphor, literary style, and verbal wit persuasively argue for the generality of the model. No psychologist has ventured an account of verbal behavior of this complexity, and with certain qualifications, it is a remarkably plausible account. Though structural linguists will wonder why Skinner finds their contributions of so little use, all should be impressed by the ingenuity of his discussion of grammar and syntax.

There is, however, something puzzling about the author's spirited rejection of "ideas," "images," "intentions," and "meanings" as "fictional causes" (page 5) and "explanatory fiction(s)" (pages 6-7). Though this position is maintained throughout, he acknowledges that "some verbal behavior [for example, "I feel depressed"], however, is under the control of stimuli to which the speaker alone is able to react" (page 30). These instances are not at all uncommon but range from "heartburn to Weltschmerz" (page 132).

After an expressed reluctance to deal with such private controls, there follows a brilliant analysis (pages 130-138) of the reinforcement conditions under which private control is established—an analysis that might well be extended to "ideas" and the like. Apparently, however, the acknowledged private controls are substantively more "emotional," and "ideas" are all too "mentalistic." It will be difficult for many to see why emotions, which are not less a challenge to operational treatment, are less objectionable as intervening constructs than cognitions. This seems a peculiar ontological distinction to make when the position is defended throughout on methodological grounds. There are repeated instances of hesitant, almost wistful, recognition of private control, but they are never given full status in the system. In a final chapter, Skinner is pressed by the thoroughness of his own analysis to acknowledge nonemotional, nonverbal, covert proc-

esses (pages 448-449), but they are not specified further. Nor is there a discussion of the implication of this acknowledgment for the behaviorist manifesto of earlier chapters.

Skinner's reluctance to give systematic recognition to private control leaves him hard put to give a testable explanation of verbal behavior when the hypothesized controls are long-ago or far away. Since the system provides no means by which prior stimulation can be stored, control must necessarily be remote, and this seems very unlike the control of a blue light over the pecking of a pigeon. Granting the methodological difficulty of assessing private controls, an adequate account of the more interesting verbal operants would seem to require biographical data of an exactness extremely difficult to obtain.

The listener is accorded comparatively slight treatment in this book on the grounds that "... an adequate account of verbal behavior need cover only as much of the behavior of the listener as is needed to explain the behavior of the speaker" (page 2). It is Skinner's particular point to propose alternatives to the traditional view that language arouses some kind of private meaning reaction in the listener. Again it is not entirely clear whether the real objection is the methodological one or a metaphysical bias that is unnecessary to the account. There is, in this context, no need even to discuss the ultimate reality of ideas and images, but their phenomenological existence is difficult to dispute. As I read a page of Skinner's book it arouses numerous ideas and images which I am accustomed to call "meaning." In a changing and complicated world, of what can I be more certain? Common sense alone is never a firm base for ultimate positions, but we should not, without very good reason, begin by flaunting it. It is Skinner's implication that reason enough would be found in the difficulty of assessing meaning reactions if they existed. Yet the problems raised by Skinner's proposed criteria of understanding will seem to many at least as great. A message is said to be "understood" if the listener is led to say the same things or if his behavior is at some future time appropriate to it. But surely we often comprehend speech or writing without being moved to say anything of the same kind, and no dependent variable is very satisfactory if we must watch and wait for it an indefinite period of time and then identify it by its "appropriateness."

It is Skinner's position on the status of intervening constructs that will draw the most controversy, although a cognitive meaning construct could be incorporated without disturbing the bulk of the system. Some may question his decision to illustrate with "[facts] well known to every educated person" (page 11) and

largely to ignore the extensive and often relevant experimental literature, particularly the research bearing on the question of mediational meaning processes. His delightful literary examples, though, not only reflect the impressive range of his reading but exercise the model in a way that the usual oversimplified experimental material could not. Whatever the point of view, readers will recognize that this is a distinguished book that makes an enormous contribution to the psychology of language. It is a rich and difficult book. But there is material here to influence all of the disciplines with a claim to the study of language.

DON E. DULANY, JR.

Department of Psychology,
University of Illinois

The Principles of Biological Control.

Interrelation of hosts and pests and utilization in regulation of animal and plant populations. Harvey L. Sweetman. Brown, Dubuque, Iowa, 1958. xii + 560 pp. Illus. \$8.75.

It is the purpose of this book to acquaint the reader with life histories, habits, methods of handling, and methods of utilizing the organisms that might be used or now are being used for the control of insects and other pests. It is thus a survey and analysis of the world literature, in so far as such a survey is feasible, covering the broad field of biological control of plants and animals. For this purpose choice has been made of species that are well known or that show common variations in the biology of the various groups of organisms. General principles of biological control are stressed wherever feasible.

This is a revision and extension of a work entitled *Biological Control of Insects*, by Sweetman, published in 1936. An extensive bibliography, arranged by chapters, for reference and documentary purposes is included at the end of the text. The book will be especially useful to teachers, graduate students, and research workers.

J. S. WADE

U.S. Department of Agriculture

Mirror to Physiology. A self-survey of physiological science. R. W. Gerard. American Physiological Society, Washington, D.C., 1958. xi + 372 pp. \$5.

The stupendous task of surveying a field of science is emphasized in this book. The detailed study, sponsored by the National Science Foundation, was started early in 1952 with the expectation that it would be completed in ap-

proximately two years. Numerous difficulties encountered in this pioneering venture delayed completion until late in 1957. Several intended goals could not be reached but are indicated in the text as worthy of further investigation. There is danger that survey data may become obsolete if there is delay in publication. The information on incomes in chapter 5 demonstrates this hazard.

The first chapters briefly summarize the survey and describe its origin, objectives, and operation. Difficulty is encountered in defining physiology because of its relation to biochemistry, biophysics, and many other fields of science. Perhaps a better name for this division of science would be "dynamic biology." Other chapters discuss occupational motivations, satisfaction, and mobility of physiologists; research programs, facilities, and support; publications and societies; training and recruitment; and the public and physiology. The final chapter is devoted to recommendations based on the interpretation of the survey findings. The appendixes (107 pages) are a useful conclusion to the book.

In reviewing this text, one is impressed with the great effort spent in collecting, clarifying, and interpreting data and ideas for a better understanding and appreciation of physiology. It should prove a very useful reference source for administrators and students.

ROBERT G. KESEL

Commission on the Survey of Dentistry
in the United States,
American Council on Education

Relativity for the Layman. James A. Coleman. (A Mentor book.) The New American Library, New York, 1958. 127 pp. Illus. \$0.50.

This is a paperback edition of the 1954 book of the same title, which was reviewed in the *Scientific Monthly* in September 1955.

A great deal of allowance must undoubtedly be made for the necessity for using the popular form of scientific writing. One wonders, however, whether the author should not be criticized for suggesting (page 118) that it may be possible at some time in the future for an astronomer with a powerful telescope to look around the finite universe and see the back of his own head. Mention of the time required for light to travel through such a distance appears to be in order.

Must we not also call it an error to say (page 24) that the sun actually rises eight minutes before it appears to rise? Is the author forgetting that it is the rotation of the earth which brings about the rising of the sun? After the earth has

turned to the proper position for sunrise, no further eight-minute waiting period is necessary.

These errors are minor, however, when compared with the author's handling of the "clock paradox"—an error that did not appear in the first edition, which made no attempt to answer the question. He is quite correct in saying that there is no paradox, but wrong in his implication that there is no difference in the ages of twins after one of them has taken a round trip to a star. As d'Abro has said in *The Evolution of Scientific Thought from Newton to Einstein*, "this particular consequence of the theory has been one of the stumbling blocks of practically every lay writer who has devoted his time to criticising the theory of relativity." And we must enlarge the group to include others who profess belief in the theory but have not made a thorough study of it. There is no room for opinion in the matter, and, as a result, mathematical physicists are virtually unanimous in their acceptance of the age difference. On the basis of both experiment and theory we have every reason to believe that travel will help to preserve youth.

Coleman has made a few improvements in the new edition—for instance, in the historical accuracy of his account of Roemer's measurement of the velocity of light through observations of Jupiter's moons.

After cautioning them against the author's treatment of the "clock paradox," I shall gladly recommend the book to my students. Inexpensive popular books on science are doing a great deal to familiarize our young people with scientific concepts. This is especially true when the reading is as palatable as it is in Coleman's little book.

MARVIN G. MOORE

Department of Mathematics,
Bradley University

Scientists' Choice. A portfolio of photographs in science selected and described by leading scientists. F. M. Branley, Ed. Basic Books, New York, 1958. \$4.95.

This is a collection of excellently reproduced photographs—self-matted, 11 by 14 inches in size, and suitable for hanging on the walls of a laboratory, study, library, or office. The subject matter ranges from the microcosmic to the macrocosmic.

In the microcosmic field are an electron micrograph of bacteriophage, an x-ray diffraction pattern of an ice crystal, and a living cell seen through a phase-contrast microscope. The macrocosm is represented by photographs of the fantastic Horsehead nebula, in the

constellation of Orion, and the Crab nebula—the latter taken in crimson light, which reveals structures not visible to normal vision.

Included in the portfolio is a booklet, *Using Your Camera in Science* (31 pages), by Jerry A. Schur, head of the photography department at Stuyvesant High School in New York. This pamphlet is too brief to be of much use to any but the veriest tyro in photography.

MORRIS C. LEIKIND
Armed Forces Institute of Pathology,
Washington, D.C.

Einführung in Theorie und Anwendung der Laplace-Transformation. Ein Lehrbuch für Studierende der Mathematik, Physik und Ingenieurwissenschaft. Gustav Doetsch. Birkhäuser, Basel, Switzerland, 1958. 301 pp. Illus. F. 39.40.

Many books, most of them designed primarily for engineers, have been written on the Laplace transform—for example, the various books under such titles as "Operational Calculus," "The Mathematics of Circuit Analysis," and so forth. In many cases the authors have made haste to make applications to differential equations, with the result that the essential mathematical theory has been either largely omitted or only carelessly handled, and the conditions under which the theorems used are valid have often not been properly stated. Proofs, if given at all, have seldom been adequate. In contrast, the mathematical treatises on the subject have been extensive. To fill this gap between theoretical treatises and typical engineering texts, Doetsch has written this excellent book.

After a brief mathematical and physical introduction to the Laplace integral, the theory is systematically developed. Questions of convergence and uniqueness are immediately faced. Chapters follow on the Laplace transform as an analytical function and on the transform under integration, differentiation, and convolution. The theory is then applied to initial value problems in ordinary differential (and difference) equations. The physical illustrations are well chosen. Next, there are developed the theory of the complex inversion formula, the Fourier transform and integral theorems, the bilateral Laplace transform, deformation of path of integration, residual theorems, expansion theorems, Parseval's equation, asymptotic behavior of the subsidiary and original functions. Chapters on differential equations with polynomial coefficients, partial differential equations, and integral equations are given.

The book is clearly written. Great care has been taken to prove each theorem in

detail, particularly in the forms required for applications. A wealth of examples to illustrate theory and the mathematical and physical applications are worked out carefully and completely. Throughout, the logical procedure which underlies the entire field can be clearly discerned.

A basic familiarity with the elements of real and complex analysis is assumed. Those working in fields utilizing transform theory will find this volume extremely useful.

RICHARD S. BURINGTON
Bureau of Ordnance,
U.S. Navy Department

Frontiers in Cytology. Sanford L. Palay, Ed., Yale University Press, New Haven, 1958. xii + 529 pp. Plates. \$9.75.

This volume, dedicated to the memory of the late Henry Bunting of Yale University, includes a biography of Bunting (by W. S. Albrink) and a bibliography of his writings, together with 16 reviews written by distinguished authors and covering research frontiers in the field of cytology. The reviews and their contributors are as follows: "Henry Bunting," W. S. Albrink; "Current concepts of cellular structures," E. W. Dempsey; "Structural specializations of the cell surface," D. W. Fawcett; "Chromosomes: Their constitution and function," A. R. T. Denués; "Studies on mitosis in purine-treated tissue cultures," J. J. Bieseke; "Changes in the desoxyribonucleoprotein complex during the cell cycle," D. P. Bloch; "Pentose nucleic acids in relation to nuclear and cytoplasmic functions," J. I. Nurnberger and M. W. Gordon; "Intracellular Lipids: Their detection and significance," H. W. Deane; "Some aspects of protein histochemistry, with special reference to protein hormones," R. J. Barnett; "A small particulate component of the cytoplasm," G. E. Palade; "The morphology of secretion," S. L. Palay; "The cytology of striped muscle," H. S. Bennett; "Cell transformation and differentiation in regenerating striated muscle," G. C. Godman; "Pathological swelling and vacuolization of cells," E. E. Manuelidis; "Cellular reaction during virus infections," W. H. Gaylord, Jr.; "The dermal ground substance of the mesenchyme as an element of natural resistance against infection and cancer," F. Duran-Reynals; and "Collagen and reticulin," W. G. Banfield.

These reviews, delivered as lectures in the winter of 1955, collected by the editor (S. L. Palay) during 1956, and in many instances brought up to date in the spring of 1957, cover a wide range of topics of contemporary interest in mod-

ern cytology. The material is well organized, the reviews are written in a concise, clear style, and the content is fully substantiated by frequent reference to the world's scientific literature. For example, more than 2000 original publications are cited in this work. The illustrations, 253 in all, are collected as plates at the end of the volume and are of good quality. The index slightly exceeds eight pages and completes this fine volume, which can be recommended to all who are interested in the achievements of modern cytology.

ROBERT C. MELLORS
Sloan-Kettering Division,
Cornell University Medical College

New Books

Library of Medicinal Plants. Collected by Henry G. de Laszlo. Heffer, Cambridge, England, 1958. 56 pp. 10s. 6d. List of more than 1500 books and pamphlets (published since 1700) on phytotherapy, by author, title, place, and date of publication.

Logic Machines and Diagrams. Martin Gardner. McGraw-Hill, New York, 1958. 166 pp. \$5.

Magic and Religion. Their psychological nature, origin, and function. George B. Vetter. Philosophical Library, New York, 1958. 555 pp. \$6.

Men, Molds, and History. Felix Marti-Ibanez. MD Publications, New York, 1958. 114 pp. \$3.

Metamorphic Reactions and Metamorphic Facies. Memoir 73. W. S. Fyfe, F. J. Turner, J. Verhoogen. Geological Soc. of America, New York, 1958. 271 pp.

Microsomal Particles and Protein Synthesis. Papers presented at the first symposium of the Biophysical Society, at the Massachusetts Institute of Technology, Cambridge, Massachusetts, 5, 6, and 8 February 1958. Richard B. Roberts, Ed. Pergamon, New York and London, 1958. 178 pp. \$5.

Mineralogy and Geology of Radioactive Raw Materials. E. Wm. Heinrich. McGraw-Hill, New York, 1958. 668 pp. \$14.50.

Nomenclature of Plants. A text for the application by the case method of the International Code of Botanical Nomenclature. Harold St. John. Ronald, New York, 1958. 164 pp. \$2.50.

Nuclear Reactors for Power Generation. E. Openshaw Taylor. Philosophical Library, New York, 1958. 151 pp. \$7.50.

Perkin Centenary, London. 100 years of synthetic dyestuffs. Pergamon, London, 1958. 148 pp. \$7.50. This volume contains the four lectures delivered at the Royal Institution, London, as one of the events of the Perkin centenary celebrations. The lectures were "The life and work of Perkin" by John Read, "The development of the dyestuffs industry" by Clifford Paine, "The tinctorial arts today" by John Gwynant Evans, and "The development of organic chemistry since Perkin's discovery" by Alexander Todd.

Reports

Oxygen Isotope Fractionation in Reactions Catalyzed by Enzymes

Abstract. A study has been made of some of the enzymatic mechanisms responsible for the previously reported fractionation of oxygen isotopes by whole organisms. The data indicate that the fractionation occurs through the activity of metalloenzymes.

In their respiratory processes aerobic organisms have been reported to fractionate the oxygen isotopes O^{16} and O^{18} (1, 2). The fractionation factor, which is a measure of the relative rates of consumption of the two isotopes, varies from organism to organism (1). In an attempt to study the metabolic mechanisms involved we have found that several enzymatic reactions prevalent in aerobic organisms are among the sources of the fractionation.

The cytochrome oxidase and tyrosinase enzyme systems were chosen because of their widespread occurrence in living organisms. Oxidations were carried out in a Warburg reaction vessel. The essential measurements were the number of moles of oxygen consumed and the change in the O^{18}/O^{16} ratio in the closed system. From this information a fractionation factor, α , characteristic of each reaction was calculated from the equation:

$$\alpha = \frac{\ln n/n_0}{\ln y/y_0 + \ln n/n_0}$$

where n_0 is the number of moles of oxygen in the container at time t_0 when the reaction starts, n is the number of moles of oxygen at time t , y_0 is the percentage of O^{18} in the oxygen at time t_0 , and y is the percentage of O^{18} in the oxygen at

time t ; α is defined as the ratio of the percentage of O^{18} in the n moles of oxygen in contact with the respiring mechanism at time t to the percentage of O^{18} in the dn moles of oxygen consumed between t and $(t + dt)$. The equation above is based on the assumption that α is constant.

Rat liver mitochondria were used as the source of cytochrome oxidase. The standard Warburg assay for cytochrome oxidase was followed; succinate was used as substrate (3). For the two tyrosinase reactions the Warburg assay procedures recommended by Mallette and Dawson (4) were used. Using both *p*-cresol and catechol as substrates made it possible to compare the fractionation involved in the two types of tyrosinase activity. The tyrosinase solutions used were types Ty5483 and Ty547B of the Worthington Biochemical Corp.

The mass spectrometric analyses were carried out on a mass spectrometer similar in many respects to that described by McKinney *et al.* (5). A vacuum manifold, with a mercury Toepler pump and a liquid air trap for water vapor, was constructed to transfer gas, without contamination, from the Warburg manometer to spectrometer sample tubes. The Warburg manometer was modified

slightly to prevent loss of manometer fluid during extraction of the gas sample. For convenience, atmospheric air was used, since the spectrometer was sensitive enough to obviate the need for pure oxygen.

The individual measurements and average values of α are listed in Table 1. All of these values lie within the range of measurements reported in earlier papers for whole organisms (1, 2). The measurements with cytochrome oxidase were made at two different temperatures, 37° and 25°C. Originally it was decided to run these reactions at the higher temperature in order to increase reaction rate. Later it was found that reaction rate depended more on the quality of the rat liver than on the temperature, and that an adequate reaction rate was obtained at 25°C with good liver preparations. The lower temperature was used in the remainder of the measurements, since less time was required to bring the reaction vessel to the temperature of the bath.

It might be worth while to measure α as a function of temperature, as it is known that the relative reaction rates of O^{16} and O^{18} vary slightly with temperature (6); however, the enzyme preparations used are active only in a narrow temperature range (10° to 40°C), and in this range variations in α are probably insignificant (± 0.001). The data indicate that α for each type of reaction is independent of average reaction rate, time of reaction, and total oxygen consumption. Control runs were made by keeping the enzyme preparations in the Warburg vessels separated from their substrates. In the control runs no fractionation was found.

The variations in α from system to

Table 1. Measurements of fractionation factor (α) for the cytochrome oxidase and tyrosinase systems.

Sample	Temp. (°C)	Total O_2 consumption (ml)	Total reaction time (min)	α
<i>Cytochrome oxidase</i>				
1	37	0.115	80	1.015
2	37	0.160	90	1.014
3	37	0.198	28	1.011
4	25	0.194	30	1.012
5	25	0.153	32	1.011
Av. α				1.013 \pm 0.002
<i>Cresolase</i>				
1	25	0.320	130	1.011
2	25	0.173	45	1.011
3	25	0.183	30	1.007
4	25	0.199	40	1.015
5	25	0.190	38	1.008
Av. α				1.010 \pm 0.002
<i>Catecholase</i>				
1	25	0.186	60	1.007
2	25	0.199	70	1.014
3	25	0.222	70	1.011
Av. α				1.011 \pm 0.004

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should not repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper. (Since this requirement has only recently gone into effect, not all reports that are now being published as yet observe it.)

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to one 2-column figure (that is, a figure whose width equals two columns of text) or to one 2-column table or to two 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [Science 125, 16 (1957)].

system are not significant. This might be expected for the two tyrosinase reactions, because the monohydric oxidation involves conversion to *o*-dihydric form as a first step (7). For this reason the α measured for the complete monohydric oxidation is an average for the two steps in the reaction, and this average is weighted toward the *o*-dihydric step, since two molecules of oxygen are involved in the *o*-dihydric step for each molecule of oxygen in the monohydric step. For other enzymatically controlled processes a significant difference in α for two different reactions catalyzed by the same enzyme would indicate the presence of more than one active site on the enzyme.

In the previously reported data on living systems average α values ranged from 1.007 for frogs to 1.025 for spinach leaves (1). It is probable, therefore, that fractionation processes other than the three enzyme reactions occur in living systems, and further research is indicated. The fractionation factors obtained in the present work would be expected to be closest to the values for unicellular organisms, because in these organisms there are no complex oxygen transport systems which might cause significantly different fractionation. At present the only data available on unicellular organisms are for bacteria, for which Lane and Dole (1) reported an average value of 1.015. The significance of this average value is questionable, however, since it is the result of a simple average of seven values of α ranging from 1.008 to 1.029 for two different types of bacteria. Therefore, the fact that 1.015 is close to the values for the enzymes reported here is not necessarily significant.

DANIEL E. FELDMAN
HENRY T. YOST, JR.
BRUCE B. BENSON

Departments of Physics and Biology,
Amherst College,
Amherst, Massachusetts

References and Notes

1. G. A. Lane and M. Dole, "Fractionation of oxygen isotopes during respiration," *Science* 123, 574 (1956).
2. M. Dole, R. C. Hawkins, H. A. Barker, "Bacterial fractionation of oxygen isotopes," *J. Am. Chem. Soc.* 69, 226 (1947).
3. W. C. Schneider and V. R. Potter, "The assay of animal tissues for respiratory enzymes," *J. Biol. Chem.* 149, 224 (1943); E. F. Hunter, "Coupling of phosphorylation with oxidation," in *Methods in Enzymology*, S. P. Colowick and N. O. Kaplan, Eds. (Academic Press, New York, 1955), vol. 2.
4. M. F. Mallette and C. R. Dawson, "Measurement of the cresolase activity of tyrosinase," *J. Am. Chem. Soc.* 69, 466 (1947).
5. C. J. McKinney, J. M. McCrea, S. Epstein, H. A. Allen, H. C. Urey, "Improvements in mass spectrometers for the measurement of small differences in isotope abundance ratios," *Rev. Sci. Instr.* 21, 724 (1950).
6. R. Bernstein, " O^{18} isotope effect in the reaction of oxygen with copper," *J. Chem. Phys.* 23, 1797 (1955).
7. J. B. Sumner and K. Myrbach, *The Enzymes* (Academic Press, New York, 1951), vol. 2, part 1.

20 August 1958

16 JANUARY 1959

Condyllostoma—an Enemy of Bivalve Larvae

Abstract. In laboratory cultures, where larvae of such bivalves as oysters and clams were kept together with large ciliates of the family Condyllostomidae, the latter were seen ingesting the larvae. A single *Condyllostoma* could contain as many as six larvae. Related species may destroy many bivalve larvae in nature.

Because of their small size and long pelagic existence, larvae of such bivalves as oysters, clams, and mussels are eaten by many holoplanktonic animals ranging from protozoans to fishes. Thorson (1), in his excellent account of reproduction and larval development of Danish marine invertebrates, offers a brief review of the enemies of pelagic larvae. His review, however, shows that, with the exception of the dinoflagellate *Noctiluca*, few protozoa subsist, in part, on lamellibranch larvae. My co-workers and I think, therefore, that our observations of *Condyllostoma* sp., a heterotrich of the family Condyllostomidae, feeding on larvae of the hard clam, *Venus mercenaria*, and the American oyster, *Crassostrea virginica*, are of biological interest and, perhaps, practical significance.

The discovery that *Condyllostoma* feeds on lamellibranch larvae was made last winter when populations of an unidentified species of *Condyllostoma* established themselves in several large glass vessels serving as intermediate reservoirs for mixed phytoplankton cultures which were fed routinely to the oysters and clams maintained in special trays during the winter (2). The temperature in these vessels usually ranged between 16.0° and 20.0°C, and the salinity of the water was normally near 27.0 parts per thousand. Individual *Condyllostoma* varied in size from approximately 400 to 900 μ when expanded. In some instances their peristomes reached a length of 225 to 250 μ . They were apparently well adapted to the conditions under which they existed, because small groups, when placed in 500-cm³ beakers to which a considerable quantity of mixed phytoplankton was added, lived for 2 to 3 months.

The first observation that *Condyllostoma* ingests lamellibranch larvae was made when some of the plankton containing these ciliates was fed to cultures of young larvae of the common clam, *Venus mercenaria*. While examining the larvae, we noticed that some were guided into the gullet by the undulating membrane in the peristome of *Condyllostoma* and that they were finally engulfed by the ciliates.

The number of larvae that can be ingested by a single *Condyllostoma* depends upon the size of the predator and the size of the larvae. In one individual, measuring 661 μ and having a peristome approximately 178 μ long, six larvae could



Fig. 1. *Condyllostoma* with two ingested larvae of *Venus mercenaria* (3). (About $\times 100$)

be seen. In smaller individuals, such as the one shown in Fig. 1, only one or two larvae were found. Progressive digestion of the soft parts of the ingested larvae was indicated by the changes occurring in their appearance. Usually the ones ingested first were distinctly paler in color than those ingested later, probably because of the disappearance of the fleshy part. Regardless of the frequent and prolonged observations on feeding *Condyllostoma*, ejection of the shells of the larvae has never been observed. It is possible, therefore, that the shells also are eventually entirely digested within the body of the predator.

Perhaps what we saw taking place under laboratory conditions occurred because of the crowding of *Condyllostoma* and lamellibranch larvae. It would probably seldom take place in nature, largely because *Condyllostoma* is not very common on oyster bottoms or in the masses of water over the oyster beds where larvae are found during the summer. Our observations suggest, however, that members of another closely related family, Folliculinidae, may present a danger. These ciliates are at times extremely numerous in oyster-producing areas such as Chesapeake Bay, where, on occasion, they virtually cover the oyster shells planted as cultch to obtain a new generation of oysters. Some of these may be capable of engulfing oyster larvae, especially when the latter descend to the bottom to undergo metamorphosis into juvenile oysters. The same may be true of other members of the suborder Heterotrichina in which the peristomes and gullets may expand to become large enough for the passage of lamellibranch larvae. Such studies suggest many interesting possibilities.

V. L. LOOSANOFF

U.S. Fish and Wildlife Service,
Marine Biological Laboratory,
Milford, Connecticut

References and Notes

1. G. Thorson, *Medd. Kommissionen For Danmarks Fiskerigt Havundersogelser Ser.: Plankton* 4, 1 (1946).
2. V. L. Loosanoff, *Ecology* 32, 748 (1951).
3. I wish to express my thanks to Mrs. Matoira Chanley for taking the photograph.

7 November 1958

Influence of Genetic Strain and Environment on the Protein Content of Pulses

Abstract. About 100 pure-bred samples of nine varieties of pulses raised in different state agricultural farms of India in 1957, when analyzed, indicated variations in the protein content of a single variety extending up to 60 percent in some cases, depending upon the strain and the locality where grown.

Pulse is one of the most important sources of vegetable protein food in India. There are six or seven important varieties, and the total annual production comes to more than 10 million tons (1). Studies with limited data on the chemical composition, digestibility, and biological values (2) indicate that the

protein content of these pulses varies from 20 to 30 percent; the digestibility, from 75 to 95 percent; and the biological value, from 45 to 70 percent.

In view of the importance of protein food in the maintenance of the health of an increasingly vast population, large-scale experiments have already been undertaken in different parts of the world, particularly in the United States, which show that the nutritional value of the plant food supply, and particularly of specific food nutrients, apart from the total quantity produced, is governed by various factors such as genetic strain and environment, including climate and soil conditions. There is experimental evidence in the literature that the strain and the nature and degree of fertiliza-

tion greatly influence not only the yield of a particular crop but also the nutrient content of a specified harvested crop. It has been shown that a given variety of wheat can vary as much as 20 percent in protein content, according to the locality where it is grown (3). The influence of genetic factors on the protein content of the corn kernel (4), and of plant variety and amount of nitrogen fertilization (5) on the protein and amino acid distribution in corn, has also been demonstrated.

In view of the foregoing findings and the fact that any nutritional program must proceed on the basis of nutritional quality of the foods grown in a particular locality, it was considered desirable to undertake a nutritional survey of all varieties of pulses grown in different parts of this country in order to study the degree of variation in the protein contents of pulses grown from various strains and under different soil and climatic conditions (6).

About 100 samples of pure strain pulses were collected from the 1957 crop from different state agricultural farms for the purpose of this study. The significant findings regarding the distribution of protein are summarized in Tables 1, 2, and 3.

The results as recorded in Table 1 tend to show that when the same strain of any variety of pulse is raised in different localities, a variation of 13 to 34 percent in the protein content occurs, depending upon the nature of soil conditions.

Similar variation in the protein content is also found (see Table 2) where pulses of different strains are grown in the same locality. The degree of such variation depends mainly on the nature of the genetic strain.

In Table 3, the pulses with maximum and minimum protein content, as grown in different parts of the country, are reported.

It may be seen from the results that a wide variation in the protein content exists, exceeding even 50 percent in some cases, depending upon the genetic strain and the locality where the pulses are grown. It is difficult to conclude at this stage, with the limited data, whether any relationship exists between the yield and the protein content. It will be, however, of much advantage if the protein level can be raised, even when the yield is not sufficiently increased in the production of these important plant foods. Work is in progress regarding the nutritional quality of the additional protein produced by the influence of genetic strain or environment or both.

G. C. ESH
T. S. DE
U. P. BASU

Bengal Immunity Research Institute,
Calcutta, India

Table 1. Variation in pulse protein obtained from pulses of the same strain grown in different localities.

Variety	Strain	Locality	Yield (lb./acre)	Protein (N x 6.25) on dry basis (%)	Variation (%)
Red gram (<i>Cajanus cajan</i>)	E.B. 38	New Delhi		23.54	12.96
Red gram (<i>Cajanus cajan</i>)	E.B. 38	Nagpur	1020	26.59	12.96
Bengal gram (<i>Cicer arietum</i>)	T. 87	Berhampur	1275	22.68	22.05
Bengal gram (<i>Cicer arietum</i>)	T. 87	Kanpur		27.68	22.05
Green gram (<i>Phaseolus aureus</i>)	T. 1	Saurashtra	120	23.79	25.05
Green gram (<i>Phaseolus aureus</i>)	T. 1	Berhampur	288	28.24	25.05
Green gram (<i>Phaseolus aureus</i>)	T. 1	Kanpur		29.75	25.05
Cow peas (<i>Vigna sinensis</i>)	Phili.	Junagadh		26.97	33.63
Cow peas (<i>Vigna sinensis</i>)	Phili.	Saurashtra	1950	36.04	33.63
Bengal gram (<i>Cicer arietum</i>)	Chaffa	Nipad	800	20.05	33.82
Bengal gram (<i>Cicer arietum</i>)	Chaffa	Junagadh	518	26.83	33.82

Table 2. Variation in pulse proteins in pulses of different strains grown in the same locality.

Variety	No. of strains	Locality	Range of protein (%) (on dry basis)
Bengal gram (<i>Cicer arietum</i>)	4	Berhampur-W. Bengal	22.68-27.94
Bengal gram (<i>Cicer arietum</i>)	6	Ujjain-Madhya Bharat	17.92-24.33
Bengal gram (<i>Cicer arietum</i>)	4	Nagpur-Bombay	17.55-23.73
Bengal gram (<i>Cicer arietum</i>)	4	Parbani-Bombay	20.46-22.64
Red gram (<i>Cajanus cajan</i>)	4	Berhampur-W. Bengal	24.80-28.42
Red gram (<i>Cajanus cajan</i>)	4	Nagpur-Bombay	23.30-26.59
Red gram (<i>Cajanus cajan</i>)	4	Parbani-Bombay	17.98-23.55
Lentil (<i>Lens esculenta</i>)	3	Berhampur-W. Bengal	29.15-30.84
Black gram (<i>Phaseolus mungo</i>)	4	Ujjain-Madhya Bharat	21.97-28.60

Table 3. Maximum variation in pulse proteins when both the strain and the environment vary.

Variety	Strain	Locality	Yield (lb./acre)	Protein (N x 6.25) on dry basis (%)	Variation (%)
Lentil (<i>Lens esculenta</i>)	C.T. 31	Berhampur	1440	30.84	17.71
Lentil (<i>Lens esculenta</i>)	T. 36	Kanpur		26.20	17.71
Khesari (<i>Lathyrus sativus</i>)	Indore T ₂ -12	Bhuva	925	32.49	26.13
Khesari (<i>Lathyrus sativus</i>)	No. 11	Nagpur	432	25.76	26.13
Pea (<i>Pisum sativum</i>)	D. Comando	Junagadh	1905	27.77	28.92
Pea (<i>Pisum sativum</i>)	Khaperkhata	Ujjain		21.54	28.92
Black gram (<i>Phaseolus mungo</i>)	Gwalior 2	Gwalior	600	28.60	30.18
Black gram (<i>Phaseolus mungo</i>)	Ujjain 15	Ujjain		21.97	30.18
Green gram (<i>Phaseolus aureus</i>)	G.G. 188	R. Nagar	550	34.01	42.96
Green gram (<i>Phaseolus aureus</i>)	T. 1	Saurashtra		23.79	42.96
Bengal gram (<i>Cicer arietum</i>)	Select 10	Berhampur	1440	27.94	59.20
Bengal gram (<i>Cicer arietum</i>)	D8	Nagpur	543	17.55	59.20
Red gram (<i>Cajanus cajan</i>)	Gwalior 3	Gwalior	1200	28.86	60.51
Red gram (<i>Cajanus cajan</i>)	No. 76-23	Parbani		17.98	60.51

References and Notes

1. G. C. Esh, *J. Proc. Inst. Chemists (India)* 30, 21 (1958).
2. S. P. Niyogi, N. Narayana, B. P. Desai, *Indian J. Med. Research* 19, 1041 (1932); M. Swaminathan, *ibid.* 25, 381 (1937); G. C. Esh and J. M. Som, *Indian J. Physiol. and Allied Sci.* 6, 61 (1952).
3. L. A. Maynard, *J. Am. Med. Assoc.* 143, 807 (1950).
4. K. J. Frey, *Cereal Chem.* 28, 123 (1951); R. C. Miller, L. W. Aurand, W. R. Flach, *Science* 112, 57 (1950); L. D. Rodriguez, C. H. Hunt, R. M. Bethke, *Cereal Chem.* 27, 67 (1950).
5. H. H. Mitchell, T. S. Hamilton, J. R. Beades, *J. Nutrition* 48, 461 (1952); H. E. Sauberlich, Wan-yuin Chang, W. D. Salmon, *ibid.* 51, 241 (1953).
6. This study was supported by the Indian Council of Medical Research, Government of India. We are also indebted to all state agricultural authorities for their kind cooperation in supplying pure strain samples of pulses.

28 July 1958

Changes in Psychological Test Performances of Brain-Operated Schizophrenics after 8 Years

Abstract. Long-term effects of topectomy showed statistically significant losses not present shortly after psychosurgery in eight of 14 psychological test measures. Site of operation, length of postoperative interval, age, and nature of the measure were factors determining the effects of brain damage.

Increasing and differentiated populations of brain-damaged subjects have become available for studies by neurologists and psychologists as a result of developing techniques in brain surgery, first in cases of brain wounds and tumors and later with the advent of "psychosurgery." In both fields of study there are sources of ambiguity, and the contradictory findings that have been reported (often in apparently similar investigations) are not surprising.

The New York State Brain Research Project, 1948-1950 (1), the last of three related projects that sought to control some of the variables in earlier studies, reported conclusions of no "permanent" decrements in "intellectual function" following psychosurgery (topectomy). This finding was based on comparisons of psychological test scores from preoperative and postoperative (within 120 days following surgery) examinations of 45 operated and 33 nonoperated schizophrenics. The conclusions were in agreement with findings of no losses in the two related projects [Columbia-Greystone I (2) and II (3)], which also included control subjects] and of numerous other studies. Early postoperative losses were interpreted as transient in the Columbia-Greystone studies because of increasing scores by the operated subjects in successive postoperative tests; in the New York State Brain Research Project, because of smaller decrements in the single examinations administered after greater postoperative intervals. The

"drop and rise" pattern was considered a reflection of temporary physiological conditions in the brain.

In 1957, after a postoperative interval of 8 years, 28 operated and 24 nonoperated subjects of the original New York State Brain Research Project were retested with the same psychological instruments. These 52 subjects had been originally grouped according to age (as of March 1957) and symptom complex into a C group—older (mean age 57.5 years, with primarily a retarded hebephrenic symptom complex)—and a D group—younger (mean age 41.9 years, with primarily a paranoid symptom complex). Controls had been drawn from the same pool of patients satisfying the selection criteria of several cooperating disciplines. The present follow-up study was restricted to subjects still at Rockland State Hospital, Orangeburg, New York; the remaining subjects were not available, due to transfers, deaths, and parole of four controls and three operated patients.

Surgery consisted of either an orbital topectomy [bilateral excision of Brodman's areas 11 (sometimes including portions of 47) and 10, and of Walker's area 13, from the lower regions of the forebrain], or superior topectomy [bilateral excision of Brodman's areas 9 (sometimes including parts of 10), 8, and 32, from the upper regions of the forebrain]. The amount of cortical tissue excised in either operation was reported to be 30 to 35 g from each hemisphere of the forebrain.

Following procedures of the original study, the 11 subtests of the Wechsler-Bellevue Form I, the revised Capps Homographs, the Porteus Maze, and the

Weigl Sorting test were readministered twice to each subject, with an interval of 30 days between the two administrations. Comparisons of the 8-year postoperative and preoperative mean scores showed poorer performances by the operated subjects in all 14 different measures, intelligence quotients, and composite scores (sums of 13 standard scores). Differences among operated and control subjects were further analyzed and tested for significance by the analysis of covariance in comparisons of groups on the bases of operation (operated and nonoperated subjects), site of excision (orbital and superior topectomy), and age (younger and older subjects). Losses by the operated groups among the 14 different measures showing poorer performances were statistically significant in several measures for each of these three factors, as shown in Table 1.

Differences between the two operative sites are shown in the table by the direct comparisons of the superior and orbital groups, as well as by comparisons of each operated group with its appropriate control. The greater losses resulting from superior topectomy when compared to orbital topectomy are in agreement with results of early postoperative studies of cases with superior lesions by Malmö (4), Penfield (5), and Petrie (6).

Differences in the effects due to age of the subject are shown in the table by the statistically significant losses by older operated groups (C groups). These differences appeared also when preoperative, early postoperative, and 8-year postoperative scores were compared. The older operated group showed a gradient of successive postoperative losses in seven of 13 measures. This gradient of increas-

Table 1. Table of significant differences. Comparisons of preoperative and 8-year postoperative test scores for C-group (older) and D-group (younger) and for superior-group and orbital-group topectomized patients, with appropriate controls (Weigl shift or non-shift performance is omitted). DSp, Digit Span subtest; Arith, Arithmetic subtest; PA, Picture Arrangement subtest; BD, Block Design subtest; OA, Object Assembly subtest; DSbl, Digit Symbol subtest; FS, Full Scale IQ; VS, Verbal Scale IQ; PS, Performance Scale IQ; PM, Porteus Maze test; CH, revised Capps Homographs; CS, Composite Score.

Groups	No.	Test										
		Wechsler-Bellevue Examination Form I								PM	CH	CS
		Dsp	Arith	PA	BD	OA	DSbl	FS	VS			
All operated	28	10.36*	9.63†				6.96†				5.13†	14.79*
All control	24											
All superior	17	4.82†	6.97†				14.44*	6.49†	4.12†	4.93†		17.33*
All control	24											
All superior	17	6.14†										
All orbital	11											
D superior	12	4.59†		4.58†	5.81†		8.89†			4.51†	7.22†	
D control	11											
D superior	12			6.57†								8.36†
D orbital	7											
C operated	9		6.69†							4.48†		
C control	13											
C orbital	4					7.77†						
C control	13											
D operated	19									6.33†		9.81*
D control	11											

* Significant at the .01 level. † Significant at the .05 level.

ing losses was not shown by the younger orbital group or by the younger or older controls.

Among all the measures used, the discriminating capacity varied from practically no difference between operated and nonoperated subjects in the Picture Completion subtest to marked and statistically significant differences in eight measures. The nature of the task presented is clearly an important variable in brain-damage studies.

The marked and definitive losses by operated subjects after a postoperative interval of 8 years are in sharp contrast to the conclusions of no "permanent" decrements reported by the original and two related studies. Our results also differ from reports of long-term studies by Weinstein and Teuber (7) of "frontal lobe lesions" due to "penetrating brain wounds" and by Scherer *et al.* (8) of "lobotomies." Population ambiguities in the latter studies may have obscured losses for lesions in specific areas which might have appeared if more careful differentiation among subjects had been possible.

Our findings of differences in psychological performances due to specific site, age, and length of the posttrauma interval are in agreement with reports of clinical findings by von Monakow and Mourgue (9) and Goldstein (10) and with neurological studies of cerebra with psychosurgical lesions by Yakolev (11), Meyer (12), and Le Beau (13). This unusual consonance of psychological and neurological findings in unrelated studies suggests that the changes in psychological test performance of operated subjects observed in the present study may be corollaries of changes in brain structure due to neurological degeneration following brain insult (14).

AARON SMITH
ELAINE F. KINDER

Topectomy Follow-up Project
(Psychology), Rockland State Hospital,
Orangeburg, New York

References and Notes

1. N. D. C. Lewis, C. Landis, H. E. King, *Topectomies* (Grune and Stratton, New York, 1956).
2. Columbia Greystone Associates (first group), *Selective Partial Ablations of the Frontal Cortex*, F. A. Mettler, Ed. (Hoebner, New York, 1949).
3. Columbia Greystone Associates (second group), *Psychosurgical Problems*, F. A. Mettler, Ed. (Blakiston, Philadelphia, 1952).
4. R. B. Malmö, "Psychological aspects of frontal gyrectomy and frontal lobotomy in mental patients," *Proc. Assoc. Research Nervous Mental Disease* 27, 537 (1947).
5. W. Penfield, "Symposium on gyrectomy," *ibid.* 27, 519 (1948).
6. A. Petrie, "A comparison of the psychological effects of different types of operations on the frontal lobes," *J. Mental Sci.* 98, 326 (1952).
7. S. Weinstein and H. L. Teuber, "Effects of penetrating brain injury on intelligence test scores," *Science* 125, 1036 (1957).
8. I. W. Scherer, C. J. Klett, J. F. Winne, "Psychological changes over a five year period following bilateral prefrontal lobotomy," *J. Consulting Psychol.* 21, 291 (1957).

9. C. von Monakow and R. Mourgue, *Introduction biologique à l'étude de la neurologie et de la psychopathologie* (Alcan, Paris, 1928).
10. K. Goldstein, *The Organism* (American Book Co., New York, 1939).
11. P. I. Yakolev, "Fronto-pontine bundle and associated projection fibers of the frontal lobe following frontal leucotomy," *Trans. Am. Neurol. Assoc.* 78, 286 (1953).
12. M. Meyer, "A study of efferent connexions of the frontal lobe in the human brain after leucotomy," *Brain* 72, part 3, 265 (1949).
13. J. Le Beau, "The surgical uncertainties of prefrontal topectomy and leucotomy," *J. Mental Sci.* 97, 480 (1951).
14. This work is being continued with other subjects and with other tests. The study reported here was partially supported by a research grant (M-1191) from the National Institute of Mental Health, National Institutes of Health, and by funds and assistance of the Research Foundation for Mental Health, Inc., of the New York State Department of Mental Hygiene.

8 September 1958

Taste Thresholds for Phenylthiourea among Ashkenazic Jews

Abstract. Taste thresholds for phenylthiourea were measured for 244 Ashkenazic Jews. The frequency of nontasters was 27.86 percent. In the sample, 102 individuals were of pure Polish ancestry, and the frequency of nontasters among these was significantly different from the frequencies of nontasters among Europeans and Mongoloids.

Investigations on taste dimorphism in sensitivity to phenylthiourea are of interest for population genetics and racial research, since it is possible to employ a relatively objective phenotype classification of the individuals. The populational distribution of individual taste thresholds is bimodal, and tasters can be discriminated from nontasters by use of the antimode. A racial variation in the frequencies of nontasters to phenylthiourea has been recognized (1) with the aid of the sorting technique described by Harris and Kalmus (2). Chinese (3) and Japanese (1) showed a clearly lower frequency of nontasters than the white groups (2, 4), and the frequencies found among American Indians (5) and African Negroes (3) are strikingly low. However, studies in many populations, including European and African ones, will have to be made before the general picture of genetic relations of human populations can be determined.

Since, on the grounds of blood-group data (6), Jewish populations suggest interesting evolutionary problems, we have chosen those groups for our studies. European, or Ashkenazic, and Mediterranean, or Sephardic, Jews have constituted interbreeding isolates, intermarriage with the neighboring populations probably having occurred to a relatively low extent, although to varying degrees at different times.

The purpose of the present report (7)

is to present the distribution of taste thresholds for phenylthiourea among Ashkenazic Jews and to determine to what extent the frequency of nontasters among them differs from that in other populations. By means of the sorting technique of Harris and Kalmus and with the same concentrations of the phenylthiourea solutions as those employed by them (2), the taste thresholds of 244 Jewish individuals within the age range of 7 to 23 years were determined. The sample is composed of students from a Jewish school and members of a Jewish organization, both in São Paulo (Brazil). No parent-child pair was included in the sample, as can be seen from the age limits for the group. The percentage of sib pairs was 15.2 percent, and the exclusion of such pairs had no appreciable effect on the frequency of nontasters (the percentage becomes 27.05 instead of 27.86 percent). There was no blood relationship among the different families. All the individuals in the sample descend directly, without admixture, from immigrant Jews from Central Europe. For these reasons this sample can be taken as representative of the Ashkenazic Jews. The distribution of the taste thresholds, classified by sex, is presented in Table 1.

To separate tasters from nontasters, the antimodal value was taken as falling between the thresholds 5 and 6. Table 2 shows the number of tasters and the number and percentage of nontasters among Ashkenazic Jews. The frequency of nontasters is slightly lower than that found among other European populations (2, 4), as determined by the sorting technique. It was determined that 102 individuals of the sample were persons both of whose parents were born in Poland. The frequency of nontasters among Polish Jews, who represent the typical European Jew, is clearly lower than that among other white populations. The difference in frequency of nontasters between Polish Jews and the remainder of the Jews (Table 2) was not significant ($\chi^2 = 3.46$; $P = 0.06$). This, however, could be due to the small size of the samples and to the fact that some individuals of the remainder group had one parent born in Poland. A more detailed investigation among Jews of Central Europe will clear up this question.

Mourant (6) has discussed the genetic relationships of Ashkenazic Jews with respect to their ABO and Rh blood-group systems. With regard to the ABO frequencies, Ashkenazic Jews in Central Europe resemble fairly well their neighbors, showing, like Poles and Ukrainians, a high B gene frequency (about 14 percent). Their Rh chromosome frequencies, however, are very different from those of Central Europeans. Like Medi-

Table 1. Distribution of taste thresholds for phenylthiourea among Ashkenazic Jews classified by sex.

Group	Taste thresholds																Total	
	<1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		16
Males	12	11	7	3	1	2		8	10	27	22	5	3					111
Females	14	5	9	3		1	2	5	16	31	29	13	2		1	1	1	133
Total	26	16	16	6	1	3	2	13	26	58	51	18	5		1	1	1	244

Table 2. Percentage of nontasters among Ashkenazic Jews as a whole, and among Polish Jews.

Sample	Total	Tasters (No.)	Nontasters (No.)	Nontasters (%)
Ashkenazic Jews (whole sample)	244	176	68	27.86 ± 2.87
Polish Jews	102	80	22	21.56 ± 4.07
Remainder	142	96	46	32.39 ± 3.92

Table 3. Comparative data on the frequency of nontasters among Polish Jews and among Europeans and Mongoloids.

Group	Total	Tasters (No.)	Nontasters (No.)	Nontasters (%)
Europeans*	647	443	204	31.53 ± 1.82
Polish Jews	102	80	22	21.56 ± 4.07
Mongoloids	361	333	28	7.75 ± 1.40

* Age range of the individuals: 10 to 39 years.

terraneans, the Ashkenazim have a typical CDe (R^1) frequency (about 53 percent) and a fairly high cDe (R^0) frequency (about 5 percent) as compared with Central European populations. This latter fact could indicate an African genetic component "probably received through Egypt" (8). Moreover, Ashkenazic Jews present a relatively low cde (r) frequency (about 36 percent) as compared with Central Europeans (9).

Table 3 presents a tentative comparison of the frequencies of nontasters among the Polish Jews and European populations, and among the Polish Jews and Mongoloids, investigated by means of the sorting technique. The combined data for English (2) and Danish (4) individuals were taken as representing the Europeans, and the combined data for Chinese (3) and Japanese (1) were taken as representing the Mongoloids. The difference in frequency of nontasters between Polish Jews and Europeans was significant ($\chi^2 = 4.15$; $P \approx 0.04$), and that between Polish Jews and Mongoloids was highly significant ($\chi^2 = 15.75$; $P < 0.0001$).

The frequency of the "nontaster" gene among Mongoloids is about 30 percent and among Europeans, about 55 percent. The value of 46 percent found among Polish Jews suggests a Mongoloid admixture, but it could also represent an African component acquired

before the dispersal of the Jews throughout Europe. This latter hypothesis is supported by a relatively high cDe (R^0) chromosome frequency among Jews from Central Europe (8). A further comparative investigation of the taste thresholds for phenylthiourea among Ashkenazic and Sephardic Jews from different areas of Central and Mediterranean Europe will probably be relevant to the problem.

P. H. SALDANHA
W. BEÇAK

Departamento de Biologia Geral,
Universidade de São Paulo, and
Instituto Butantan, São Paulo, Brazil

References and Notes

1. P. H. Saldanha, *Ann. Human Genet.* 22, 380 (1958).
2. H. Harris and H. Kalmus, *Ann. Eugen.* 15, 24 (1949).
3. N. A. Barnicot, *ibid.* 15, 248 (1950).
4. J. Mohr, *ibid.* 16, 282 (1951).
5. H. Kalmus, *Ann. Human Genet.* 21, 313 (1957).
6. A. E. Mourant, *The Distribution of the Human Blood Groups* (Blackwell, Oxford, 1954).
7. One of us (P.H.S.) wishes to express his gratitude to the Rockefeller Foundation for a grant to the Departamento de Biologia Geral da Universidade de São Paulo in support of the present work. We are also indebted to Mrs. Elisa Kaufmann for her permission to perform tests in a Jewish school and to Dr. O. Frota-Pessoa for his critical reading of the manuscript.
8. A. E. Mourant, *Cold Spring Harbor Symposia Quant. Biol.* 15, 221 (1950).
9. J. Gurevitch, D. Hermoni, Z. Polishuk, *Ann. Eugen.* 16, 129 (1951).

11 September 1958

Newly Found Action of Cocaine

Abstract. Cocaine augments appreciably the effects of small doses of acetylcholine on the heart rate, blood pressure, and the nictitating membrane in intact, anesthetized animals. This phenomenon assigns cocaine, thus far only known as a potentiator of adrenergic stimulation, a more general role of potentiator of both adrenergic and cholinergic neurohumors.

Hitherto cocaine has been considered only as an adrenergic potentiator. A chance observation disclosed a completely new and entirely unexpected potentiating effect of cocaine on acetylcholine responses. It was found that cocaine in this series of experiments acted as an apparent *in vivo* cholinesterase inhibitor, augmenting various acetylcholine effects. It is known, however, that cocaine is not only devoid of anticholinesterase activity but that it actually activates *in vitro* pseudocholinesterase, and this only at concentrations well above pharmacological levels (1).

Cats under alpha-chloralose (80 mg/kg) anesthesia were used. Isotonic contractions of the nictitating membrane and arterial pressure from the carotid artery were recorded in the usual manner. All drugs were administered via the femoral vein. Maximal membrane contractions after preganglionic stimulation of the cervical sympathetic trunk through shielded electrodes were obtained with a square-wave electronic stimulator.

The duration of stimulation was 5 sec at a frequency of 20 per second; a pulse width of 0.5 msec was utilized. In each cat, three control responses of 1, 2, 4, 8, and 16 μ g of acetylcholine (per kilogram) on the nictitating membrane, blood pressure, and the heart rate were recorded. After this, 3 mg of cocaine hydrochloride (per kilogram) was administered. Cocaine usually produced a primary vasodepressor and a secondary vasopressor effect. After a latency period of 60-sec duration, cocaine (3 mg/kg) itself caused the membrane to respond with a sustained, increased tension. The alteration of the baseline occurred whether or not the cervical sympathetic trunk was severed or the animals were adrenalectomized. The increased tension produced by cocaine is in itself an interesting phenomenon. If cocaine potentiates membrane contractions, this increased tension would militate against maximum potentiation. All the potentiations observed after cocaine injection are smaller than they would be if the membrane retained its normal tension.

Cocaine produced a potentiation of the acetylcholine-induced contractions of the nictitating membrane even when no acetylcholine response was observed on the nictitating membrane prior to the administration of cocaine (Fig. 1).

The effects of small doses of acetylcholine cannot be due to either ganglionic stimulation or to catechol amine release from the adrenals. In the latter part of the experiment, every animal was administered hexamethonium ion (10 mg/kg), which abolished the pre-ganglionic cervical sympathetic stimulation but did not abolish and occasionally even potentiated the height and duration of acetylcholine-induced contractions of the nictitating membrane. The last step in the experiment was the intravenous injection of 100 μ g of atropine (per kilogram), which abolished the nictitating membrane-, vasodepressor-, and cardiac effects and did not convert the acetylcholine responses into pressor effects. This proves beyond doubt that we are not dealing with "nicotinic" and allied effects of acetylcholine. The same dose of atropine did not abolish or diminish epinephrine-induced contractions after potentiation by cocaine. The vasodepressor response to epinephrine was usually, but not invariably, potentiated by cocaine. The effects of acetylcholine, before and after cocaine administration, on

Table 1. Cocaine potentiation of the typical effects of small intravenous doses of acetylcholine on the nictitating membrane and the mean arterial pressure responses of the cat (averages of data obtained from ten cats, including two adrenalectomized animals).

Acetylcholine dose (μ g/kg)	Control		Experimental					
	Amt. (mm)	Range (mm)	Cocaine, 3 mg/kg		Cocaine, additional 3 mg/kg		Hexa- methonium, 10 mg/kg	
			Amt. (mm)	Range (mm)	Amt. (mm)	Range (mm)	Amt. (mm)	Range (mm)
<i>Height of contractions of nictitating membrane (mm)</i>								
2	0.28	0-1	3.2	0-7	10.0	10	9.6	6-17
4	1.6	0-6	4.7	0-10	7.6	0-14	13.2	9-18
8	2.4	0-7	9.2	3-17	10.9	9-21	17.7	15-21
16	4.4	2-10	19.6	5-29	30.1	26-40	24.5	18-30
<i>Vasodepressor effects (mm-Hg)</i>								
2	40.5	10-60	56.0	20-70	60.0	60	26.0	2-50
4	53.8	12-82	57.6	20-92	79.8	64-90	38.4	14-50
8	43.9	8-70	59.8	20-90	58.1	45-80	53.5	18-70
16	49.4	8-70	69.4	18-110	79.0	64-90	48.8	20-80

the nictitating membrane and blood pressure are summarized in Table 1.

Feeney *et al.* (2) have already differentiated between the effects of small and larger doses of acetylcholine on the nictitating membrane. These experiments have shown that the responses to small amounts of acetylcholine given are not due to ganglionic stimulation or to catechol amine release. Cocaine potentiation, as encountered in the currently reported investigation, is not related to the hypertension and contractions of the nictitating membrane in response to "nicotinic" doses of acetylcholine (3).

A positive explanation of the results reported in the present paper is not readily available. Several hypotheses, however, may yield fruitful information: Cannon and Rosenbluth (4) have proposed that facilitation of response results from increased permeability, thus enhancing the action of the stimulating agent. If this is the true explanation, it accounts for potentiation of both epinephrine and acetylcholine, since, under normal conditions, both of these agents cause the nictitating membrane to contract. It is well known that epinephrine potentiates the action of acetylcholine on skeletal muscle. Bulbring (5) found that the response of the nictitating membrane to a dose of acetylcholine was augmented by the presence of small amounts of epinephrine, and epinephrine is potentiated by cocaine. The possibility exists that cocaine may somehow enhance the response to small doses of acetylcholine by potentiating circulating epinephrine, which in turn acts on acetylcholine. The

most likely explanation, which has been and will be further studied in this laboratory, is that cocaine changes the permeability of membrane to ions, since even in the case of sensitization of the sympathetic nervous system to epinephrine, inhibition of monamine oxidase or other enzymes is doubtful (6).

Note added in proof. Since this paper was submitted for publication, a paper by J. W. Thompson [*J. Physiol. (London)* 141, 46 (1958)] has come to our attention, showing a figure from which it is obvious that in an isolated preparation of the muscle of the nictitating membrane, the addition of cocaine to the bath fluid raised the base line and increased the magnitude of acetylcholine contraction. We are, therefore, in a position to point out a close agreement between cocaine effect on acetylcholine *in situ* and *in vitro*.

THEODORE KOPpanyi
GLORIA COMULADA FEENEY

Department of Pharmacology,
Schools of Medicine and Dentistry,
Georgetown University,
Washington, D.C.

References and Notes

1. P. J. Fraser, *Brit. J. Pharmacol.* 11, 7 (1956).
2. G. C. Feeney, M. Avery, T. Koppányi, *Federation Proc.* 15, 421 (1956).
3. T. Koppányi, C. R. Linegar, R. P. Herwick, *Am. J. Physiol.* 130, 346 (1940); D. Danielopolu and I. Marcu, *Compt. rend.* 215, 427 (1942).
4. W. B. Cannon and A. Rosenbluth, *Autonomic Neuroeffector Systems* (Macmillan, New York, 1937).
5. E. Bulbring, *J. Physiol. (London)* 103, 55 (1944).
6. H. Veldstra, *Pharmacol. Revs.* 8, 339 (1956).

30 July 1958

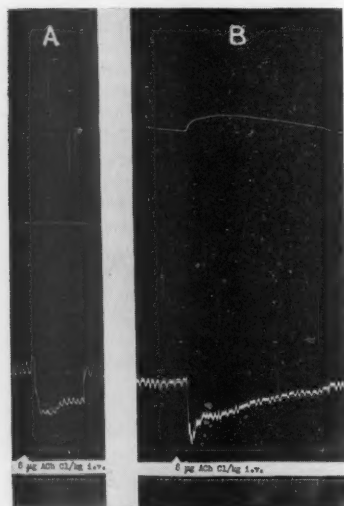
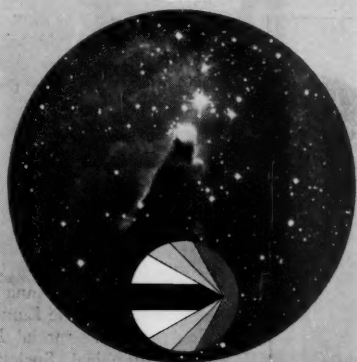


Fig. 1. Effect of intravenous injections of 8 μ g of acetylcholine chloride (per kilogram) before (A) and after (B) cocaine administration (3 mg/kg); 2.8 kg cat. Top line, nictitating membrane response; second line, blood pressure and cardiac inhibition; third line, injection mark; fourth line, time: 10 sec. The time interval between the cocaine administration and the second acetylcholine injection was 12 min. Note the elevated baseline after cocaine administration (nictitating membrane).

SPACE PHYSICISTS



Lockheed Missile Systems Division is expanding its space physics studies to keep pace with progress in this rapidly growing field of fundamental research.

Positions are available for physicists with advanced degrees, at our Palo Alto facilities in the Stanford Industrial Park, for work in basic research on the physics of the earth's upper atmosphere and beyond. Typical research projects include: measurement of atmospheric composition and density at satellite altitudes; laboratory experiments on upper atmospheric atomic and molecular reactions; hydromagnetic interactions with the earth's magnetic field; simulation and study of meteor impacts; and particle radiation.

For further information, please write: Research and Development Staff, Dept. A-44, 962 W. El Camino Real, Sunnyvale, Calif.

Lockheed MISSILE SYSTEMS DIVISION

SUNNYVALE, PALO ALTO, VAN NUYS,
SANTA CRUZ, SANTA MARIA, CALIFORNIA
CAPE CANAVERAL, FLORIDA
ALAMOGORDO, NEW MEXICO

BRUSSELS WORLD FAIR GRAND PRIX AWARD



HITACHI ELECTRON MICROSCOPE WINS FIRST PLACE FOR PERFORMANCE EXCELLENCE

These fine instruments are finding wide acceptance throughout the United States as well as the world market of Electron Microscopes.

*For further information
contact:*

ERB & GRAY SCIENTIFIC, INC.

854 S. Figueroa St.
Los Angeles 17, California

Exclusive agent.

Meetings

Darwin-Wallace Centennial

This year is the centenary of the reading of the joint paper "On the tendency of species to form varieties; and on the perpetuation of varieties and species by natural means of selection," by Charles Robert Darwin and Alfred Russel Wallace. It is appropriate, therefore, that biologists throughout the world should be celebrating the initial presentation of the theory of natural selection to the

Linnean Society of London in 1858, for this first reading of the Darwin-Wallace paper was indeed an event of great significance in the history of science and in the more comprehensive history of mankind.

The coincidence of this centenary with the meetings of the 15th International Congress of Zoology in London was made the occasion for various ceremonies and events to honor the great revolution in human thought initiated by Darwin and Wallace. Furthermore, since this year is the bicentenary of the tenth edition of the *Systema Naturae* by

Linnaeus, the celebration of the Darwin-Wallace centenary was linked with ceremonies to honor the great advance in biological thought and practice initiated by the founder of modern biological nomenclature.

It was most appropriate that the Linnean Society should mark this date, not only because of Linnaeus but also because it was in the meeting room of this society that the reading of the Darwin-Wallace paper took place. It was also appropriate that the Congress of Zoology should make the work of Linnaeus, Darwin, and Wallace a central theme for the meetings.

The celebration was most auspiciously inaugurated on 1 July with a meeting in the Linnean Society room, just 100 years to the day after the first reading of the Darwin-Wallace paper. Here, in the presence of the president and the council of the society and of invited guests, a Darwin-Wallace memorial tablet was unveiled, in honor of the historic meeting of a century ago.

On the afternoon of 15 July, the day before the opening of the Congress of Zoology, a special Linnaeus-Darwin-Wallace meeting of the Linnean Society was held in the Memorial Hall of the Royal Geographical Society. At this meeting, presided over by C. F. A. Pantin, president of the Linnean Society, special Darwin-Wallace medals, struck in honor of the occasion, were presented to 20 outstanding biologists (or their representatives) for their contributions to modern biological and evolutionary theory and practice. The biologists so honored were as follows: Edgar Anderson, the late M. Caullery (who had died, at an advanced age, a few days before the meeting), Ronald Fisher, R. Florin, J. B. S. Haldane, Roger Heim, J. Hutchinson, Julian Huxley, Ernst Mayr, H. J. Muller, A. N. Pavlovsky, Bernhard Rensch, George Gaylord Simpson, C. J. F. Skottsberg, Erik A. Stensiö, Hamshaw Thomas, G. Turesson, Victor van Straelen, D. M. S. Watson, and the late J. C. Willis.

Following the presentation of the medals, A. Tindell Hopwood gave a paper on "The pre-Linnaean development of taxonomy," and A. J. Cain presented a paper on "The post-Linnaean development of taxonomy."

On the evening of this same day a *conversazione* was held at the rooms of the Royal Society, the Linnean Society, and the Geological Society in Burlington House. Guests were received by Cyril Hinshelwood, C. F. A. Pantin, and C. J. Stubblefield, the presidents, respectively, of the three societies. The guests then circulated through the rooms of the three societies, in which were displayed exhibits of Darwiniana and Wallaceana. There was also a special showing of a film by H. B. D. Kettlewell, entitled

NOW a NEW Baird-Atomic Direct Reading Flame Photometer



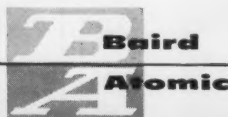
Direct Meter Readings of both Na and K from the same microsample (1/10cc)

- **DIRECT READING** — scale indicates concentrations of Na and K in Meq/l — eliminates tedious calculations
- **MICROSAMPLING TECHNIQUES** — require as little as 0.05 cc of serum to run determinations and then rerun to check . . . especially advantageous for infants and children
- **SIMPLICITY** — exceptional ease of calibration, portable, uses city or manufactured gas, no galvanometer
- **REPRODUCIBILITY** — extensive field testing shows average reproducibility of 1/2 of 1%
- **INTERNAL STANDARD**

For complete information or a demonstration of the new B-A Direct Reading Flame Photometer contact your local distributor or —

Baird-Atomic, Inc.

33 UNIVERSITY RD., CAMBRIDGE 38, MASS



Instrumentation for Better Analysis

Webster Says... QUALITY means

"The degree of
excellence and
superiority"



... at Nutritional Biochemicals Corporation
QUALITY is one of our proudest assets.

A COMPLETE SELECTION OF MORE THAN 300
AMINO ACIDS AND PEPTIDES

Typical Amino Acids

Glutamine, L, DL
Phenylalanine, D, DL, L
Homoserine
Homocysteine
Histidine, L, DL
Valine, D, DL, L
Ornithine, DL, L

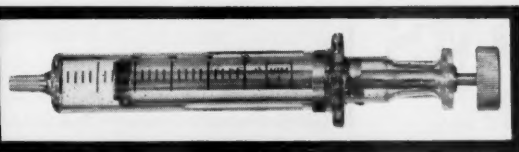
Dopa, D, L, DL
Asparagine, D, L, DL
Serine, D, L, DL
Carnosine
Citrulline, L, DL
Creatine Phosphate



**NUTRITIONAL
BIOCHEMICALS
CORPORATION**

21010 MILES AVE. • CLEVELAND 28, OHIO

Write for New Catalog—November, 1958—More than 2400 Items—Write Dept. 102



Rapid, Precise Pipetting with

HAMILTON PIPET CONTROLS

DUAL CONTROL provides for extremely accurate pipetting and liquid transfer with Hamilton Pipet Controls. Simply raise the liquid meniscus with the free-sliding plunger almost to the calibration line, then use the thumbwheel control to bring the meniscus to the scribe line with complete accuracy. Pipet Control features include:

- Glass and stainless steel construction
- Tygon tubing connection to pipet provides clean, flexible coupling
- 1 ml, 2 ml and 5 ml maximum capacities available

Order Direct—or write for literature
and prices—today!

HAMILTON COMPANY, INC.

DEPARTMENT K

1134 WHITLEY STREET • WHITTIER, CALIFORNIA

A Complete Line of Precision,
Radiochemical Handling Equipment

16 JANUARY 1959



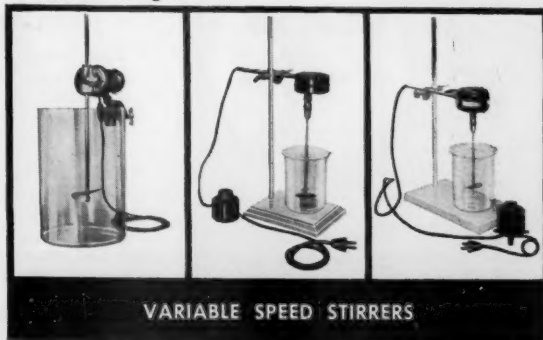
choose
EASTERN
equipment
for your
laboratory



CENTRIFUGAL AND POSITIVE PRESSURE PUMPS

Many of your laboratory needs can be handled efficiently by Eastern midget pumps. Compact design and remarkable performance make them adaptable where space and portability are factors.

Semi-enclosed, totally-enclosed, or explosion-proof motors powered from 1/30 to 1/3 h.p. offer a range of performance characteristics up to 20 G.P.M. at 15 P.S.I. Choice of metals, currents and voltages.



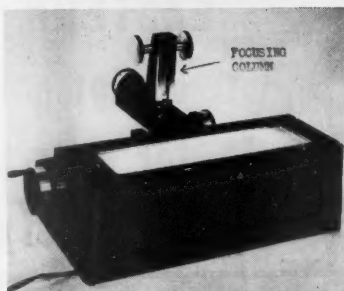
VARIABLE SPEED STIRRERS

Laboratory Stirrers from 1/100 to 1/15 h.p. are useful for a variety of stirring operations. From small quantities of light liquids, to ten gallons of viscous material, there's a non-sparking Eastern screw-clamp or ringstand mounted model ideal for your lab use.

SEND FOR FREE FOLDER

Eastern INDUSTRIES, INC.
100 SKIFF STREET • HAMDEN, CONNECTICUT

TRAVELING MICROSCOPE MOUNT



MODEL CS-56

FOR THESE PROBLEMS

- ★ Coordinate Measurements
- ★ Optical Inspection
- ★ Small Assembly Work
- ★ Linear Dimensions of Plastic, Interferograms, Electron Microscope Slides, etc.
- ★ Determination of composition of Hardened Concrete
- ★ Spot Checking and Quality Control

The CSI Microscope Stage (Traveling Microscope Mount) affords the Laboratory Technician a rugged, sturdy tool especially designed for these problems. The measuring range is 3" W x 12" L x 4 1/4" H. The stage is suitable to mount any microscope where the straight vertical focusing column is detachable from the sub-stage base. Direct readings may be had to .0001 inches (English) or .0025 mm (Metric).

Folders and Price upon request

CUSTOM SCIENTIFIC INSTRUMENTS, INC.

541 DEVON ST.

KEARNY, N.J.

RECORD YOUR OBSERVATIONS with a UNITRON PHOTOMICROGRAPHY SET!

An inexpensive accessory that duplicates the performance of costly apparatus. For every type of microscopy and photography. Easy to operate. Allows continuous observation while camera is in place, even during time exposures. Adjustable to fit the camera of your choice (35mm, #120, #127, motion picture, etc.). A valuable aid for teaching or learning.

FREE 10-DAY
TRIAL
Model ACA

\$39⁹⁵
Postpaid

UNITRON

INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.
204-206 MILK STREET • BOSTON 9, MASS.

Please rush to me, UNITRON's Microscope Catalog, Dept. 4M-3

Name _____
Company _____
Street _____
City _____ State _____

VENOMS

AAAS Symposium Volume No. 44

6" x 9", 480 pp., 113 illus.,
index, cloth, Dec. 1956

Price \$9.50. AAAS Members'
cash order price \$8.25

First International Conference on Venoms, with 95 contributors from 18 countries. Comprehensive coverage of all aspects of the problem.

This book covers poisonous fishes and marine organisms, many species of venomous snakes, the Gila monster, toads, scorpions, spiders, caterpillars, wasps and other venom-bearing insects; hyaluronidase-like substances and other spreading factors in venoms; various chemical components of venoms, coagulant and anticoagulant factors, antigenic principles; various experimental and suggested clinical uses of venoms; clinical considerations: mortality rates, treatment of many kinds of envenomation; new developments in serotherapy and types of supplementary medication; dangers of refrigeration for treatment.

Of special interest to: Physicians, pharmacologists, chemists, and zoologists.

AAAS

1515 Mass. Ave., NW, Washington 5, D.C.

"Darwin and the insect adaptations of Brazil."

On the morning of the following day, 16 July, the inaugural meeting of the Zoological Congress was held in Albert Hall; Gavin de Beer presided. Various members of the Darwin and Wallace families were seated on the rostrum. Julian Huxley delivered a special Darwin-Wallace centenary address. He traced briefly the work of Darwin and Wallace and the events leading up to the presentation of their joint paper in 1858. He pointed out in particular how loath Darwin was to publish the results of his long and extended studies until he received the stimulus from Wallace, who had been thinking along lines exactly parallel to his own. He concluded by pointing out the fact that future evolutionary progress is to a large degree within the hands of mankind.

The scientific sessions of the congress followed for a week, and at many of these evolution was an important topic for discussion.

There were excursions for congress members to Darwin's home, Down House, and on one afternoon invited guests had the privilege and pleasure of meeting various members of the Darwin family there.

During the special meetings of the Linnean Society and throughout the congress meetings the names of Darwin, Wallace, and Linnaeus were signally honored. The summer of 1958 will remain ever memorable to biologists because of them.

EDWIN H. COLBERT

American Museum of Natural History
and Columbia University, New York,
New York

Forthcoming Events

February

14. Differentiation in Current Mating and Fertility Trends, intern. symp., New York, N.Y. (American Eugenics Soc., Inc., 230 Park Ave., New York 17.)

15-19. American Inst. of Mining, Metallurgical, and Petroleum Engineers, annual, San Francisco, Calif. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

16-19. Problems in Field Studies in Mental Disorders, intern. work conf., New York, N.Y. (J. Zubin, American Psychopathological Assoc., 722 W. 168 St., New York 32.)

20-21. Epidemiology in Mental Disorders, annual meeting of the American Psychopathological Assoc., New York, N.Y. (J. Zubin, APA, 722 W. 168 St., New York 32.)

23-27. American Concrete Inst., 55th annual, Los Angeles, Calif. (W. A. Maples, A.C.I., 18263 W. McNichols Rd., Detroit 19, Mich.)

25-26. Midwest Industrial Radioisotopes Conf., Manhattan, Kan. (J. Kit-

chens, Dept. of Continuing Education, Kansas State College, Manhattan.)

25-27. Biophysical Soc., annual, Pittsburgh, Pa. (G. Felsenfeld, Dept. of Biophysics, Univ. of Pittsburgh, 325 Clapp Hall, Pittsburgh 13.)

26-28. American Acad. of Forensic Sciences, annual, Chicago, Ill. (W. J. R. Camp, AAFS, 1853 W. Polk St., Chicago 12.)

26-28. Genetics and Cancer, 13th annual symp. on fundamental cancer research, Houston, Tex. (Editorial Office, Univ. of Texas, M. D. Anderson Hospital and Tumor Inst., Texas Medical Center, Houston 25.)

27-1. National Wildlife Federation, 23rd annual convention, New York, N.Y. (NWF, 232 Carroll St., NW, Washington 12.)

March

1-2. Pennsylvania Acad. of Sciences, Gettysburg. (K. Dearolf, Public Museum and Art Gallery, Reading, Pa.)

1-5. Gas Turbine Power Conf., Cincinnati, Ohio. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

7. American Chemical Soc., Oklahoma Div., tetrasectional meeting, Tulsa. (J. W. Conant, ACS, Grand River Chemical Div. of Deere and Co., Pryor, Okla.)

8-9. American Broncho-Esophagological Assoc., Hot Springs, Va. (F. J. Putney, 1712 Locust St., Philadelphia, Pa.)

8-9. American Laryngological Assoc., Hot Springs, Va. (J. H. Maxwell, University Hospital, Ann Arbor, Mich.)

8-12. Aviation Conf., Los Angeles, Calif. (O. B. Schier, ASME, 29 W. 39 St., New York, N.Y.)

10-12. American Laryngological, Rhinological and Otolological Soc., Hot Springs, Va. (C. S. Nash, 708 Medical Arts Bldg., Rochester 7, N.Y.)

13-14. American Otolological Soc., Hot Springs, Va. (L. R. Boies, University Hospital, Minneapolis 14, Minn.)

13-15. Alabama Acad. of Sciences, Auburn. (H. M. Kaylor, Dept. of Physics, Birmingham-Southern College, Birmingham, Ala.)

14-15. Southwestern Soc. of Nuclear Medicine, 4th annual, New Orleans, La. (S. B. Nadler, SSNM, 1520 Louisiana Ave., New Orleans 15, La.)

15-20. American College of Allergists, San Francisco, Calif. (M. C. Harris, 450 Sutter St., San Francisco.)

16-19. American Assoc. of Petroleum Geologists, Soc. of Economic Paleontologists and Mineralogists, 44th annual, Dallas, Tex. (W. A. Waldschmidt, AAPG, 311 Leggett Building, Midland, Tex.)

16-20. American Inst. of Chemical Engineers, Atlantic City, N.J. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36.)

16-20. National Assoc. of Corrosion Engineers, 15th annual conf., Chicago, Ill. (NACE, Southern Standard Bldg., Houston, Tex.)

16-20. Western Metal Exposition and Cong., 11th, Los Angeles, Calif. (R. T. Bayless, 730: Euclid Ave., Cleveland 3, Ohio)

17-19. National Health Council, Chi-

Positive stop readings in 1.13 seconds

MODEL
4203B-TC-SA



SHADOGRAPH®

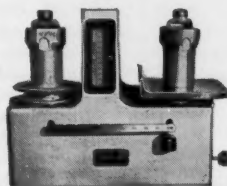
small animal balance provides visible accuracy to 350 milligrams

Model 4203B-TC-SA Shadograph is designed especially for high-speed, precision weighing of mice, chicks, frogs and small rats. It can reduce tedious weighing operations by hours . . . give you more time for other work. Light-projection indication is fast . . . provides sharp shadow-edge reading on frosted glass dial. Parallax reading eliminated. Capacity 1500 grams. Dial graduated in two columns: 0-30 grams and 15-45 grams. Shutter closes dial column not in use. Beam 100 grams in 1 gram graduations. Weighs accurately in out-of-level positions. Other models up to 3 kilos for rats, hamsters and guinea pigs.



TISSUE AND TUMOR BALANCE

Model 4142 recommended for fast, precision weighing of cancer tissue and tumors. Weighpan is shielded from air currents by clear plastic door . . . easily removed for sterilization. Rated capacity 15 grams; visible sensitivity to 5 milligrams. Movable viewer for 5-column dial, each column 3 grams with 5 milligram graduations. 5-notch beam corresponding to dial columns.



CENTRIFUGE BALANCE

Model 4206B-TC also for general laboratory use and small-animal weighing. Has tare control knob to zero the dial, or position for over-and-under reading. Capacity 3 kilos; sensitivity to 350 milligrams. Dial is graduated 0-100 grams in increments of 1 gram. Beam 500 grams by 5 grams.

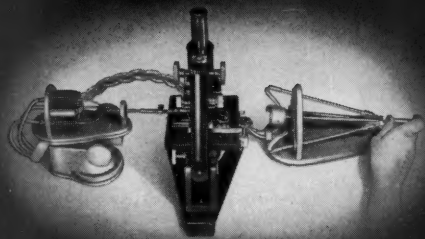
THE EXACT WEIGHT SCALE CO.

901 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Sales and Service Coast to Coast



MICROMANIPULATOR "CAILLOUX"



Unmatched flexibility of movements in all directions in space are achieved by natural hand movements under magnifications of 100 X to 2000 X without adjustment. The "Caillox" advanced design combines maximum speed, precise response and stability with unusual ease of operation. Back-lash, parasitic vibrations and lag are eliminated. Prolonged manipulations can be conducted without fatigue. Includes many additional exclusive features.

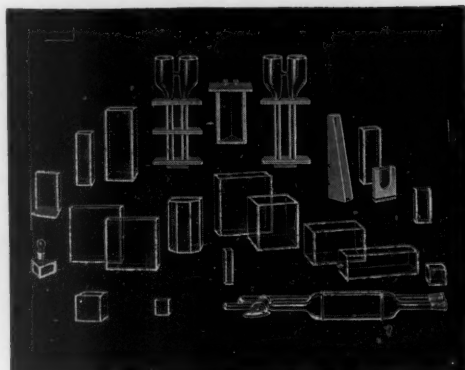
LOW IN PRICE

C. H. STOELTING COMPANY

Write for additional information

424 N. HOMAN AVE., CHICAGO 24, ILL.

GLASS ABSORPTION CELLS made by **KLETT**



SCIENTIFIC APPARATUS

Klett-Summerson Photoelectric Colorimeters—
Colorimeters—Nephelometers—Fluorimeters—
Bio-Colorimeters—Comparators—Glass Stand-
ards—Klett Reagents.

Klett Manufacturing Co.

179 East 87 Street, New York, New York



CHICAGO, U.S.A.

STUDENT MICROSCOPES

Most reasonably priced **GUARANTEED**
Microscope on the market.

Made in West Germany

NEW DESIGN
EXCLUSIVE
SAFETY FEATURES
HIGH QUALITY OPTICS
10X OCULAR
OBJECTIVES
16mm (10X) N.A. 0.27
4mm (44X) N.A. 0.66

STILL \$118.00
TEN YEAR GUARANTEE

*Write for catalogue
listing safety features*

10% Discount on 5 or more.
Models may be assorted to ob-
tain this discount

TRANSPORTATION
INCLUDED

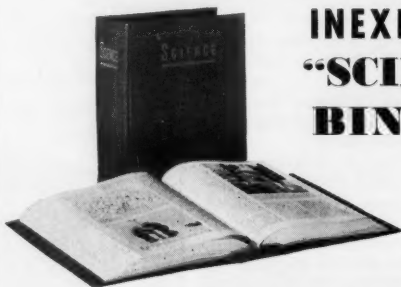


THE GRAF-APSCO CO.

5868 BROADWAY

CHICAGO 40, ILL.

INEXPENSIVE "SCIENCE" BINDERS



Keep your copies of **SCIENCE** always available for quick, easy reference in this attractive, practical binder. Simply snap the magazine in or out in a few seconds—no punching or mutilating. It opens **FLAT**—for easy reference and readability. Sturdily constructed—holds 26 issues.

Now made of stronger materials to accommodate heavier volumes.

This beautiful maroon buckham binder stamped in gold leaf will make a fine addition to your library. Only \$3.25 postpaid; add 50¢ for orders outside U.S.A. (Personal check or money order, please.) Name of owner, 75¢ extra; year of issues, 50¢ extra.

SCIENCE • 1515 Massachusetts Ave., NW,
Washington 5, D.C.

cago, Ill. (P. E. Ryan, 1790 Broadway, New York, 19.)

18-25. International Social Science Council, 4th general assembly (by invitation), Paris, France. (C. Levi-Strauss, Secretary-General, International Social Science Council, 19, avenue Kleber, Paris.)

19-21. Society for Research in Child Development, NIH, Bethesda, Md. (Miss N. Bayley, Laboratory of Psychology, National Inst. of Mental Health, Bethesda 14, Md.)

23-26. Institute of Radio Engineers, natl. conv., New York, N.Y. (G. L. Haller, IRE, 1 E. 79 St., New York 21.)

24-27. American Meteorological Soc., general, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy Street, Boston, Mass.)

27-28. Michigan Acad. of Sciences, East Lansing. (D. A. Rings, Univ. of Michigan, Dept. of Engineering, Ann Arbor.)

28. South Carolina Acad. of Sciences, Columbia. (H. W. Freeman, Dept. of Biology, Winthrop College, Rock Hill, S.C.)

29-3. Latin American Congress of Chemistry, 7th, Mexico D.F., Mexico. (R. I. Frisbie, Calle Ciprés No. 176, Zone 4, Mexico, D.F.)

30-1. American Orthopsychiatric Assoc., San Francisco, Calif. (M. F. Langer, 1790 Broadway, New York 19.)

30-12. Bahamas Medical Conf., 7th, Nassau. (B. L. Frank, 1290 Pine Ave., W. Montreal, Canada.)

31-2. American Power Conf., 21st annual, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

31-2. Symposium on Millimeter Waves, 9th, New York, N.Y. (H. J. Carlin, Microwave Research Inst., 55 Johnson St., Brooklyn 1, N.Y.)

31-5. International Committee of Military Medicine and Pharmacy, 21st session, Paris, France. (Comité International de Médecine et de Pharmacie Militaires, Hôpital Militaire, 79, rue Saint Laurent, Liège, Belgium.)

April

1-3. American Assoc. of Anatomists, Seattle, Wash. (B. Flexner, Univ. of Pennsylvania Medical School, Philadelphia 4, Pa.)

1-4. National Council of Teachers of Mathematics, Dallas, Tex. (H. T. Karnes, Dept. of Mathematics, Louisiana State Univ., Baton Rouge 3.)

1-4. National Science Teachers Assoc., 7th natl. conv., Atlantic City, N.J. (R. H. Carlton, NSTA, 1201 16 St., NW, Washington 6.)

1-4. Neurosurgical Soc. of America, Hot Springs, Va. (F. P. Smith, 260 Crittenden Blvd., Rochester, 20, N.Y.)

1-29. World Meteorological Organization, 3rd session of congress, Geneva, Switzerland. (WMO, Campagne Rigot, 1, avenue de la Paix, Geneva.)

2-3. Electrically Exploded Wires, conf., Boston, Mass. (W. G. Chace, Thermal Radiation Laboratory, CRZCM, Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass.)

2-4. Association of American Geographers, 55th annual, Pittsburgh, Pa. (J. E.

Guernsey, 9707 Parkwood Dr., Bethesda, Md.)

2-4. Association for Computing Machinery, Cleveland, Ohio. (J. Moshman, Corporation for Economic and Industrial Research, 1200 Jefferson Davis Highway, Arlington 2, Va.)

2-4. Optical Soc. of America, New York, N.Y. (S. S. Ballard, Dept. of Physics, Univ. of Florida, Gainesville.)

3-4. Eastern Psychological Assoc., Atlantic City, N.J. (C. H. Rush, Standard Oil Co. of New Jersey, Rockefeller Plaza, New York, N.Y.)

3-5. American Soc. for the Study of Sterility, Atlantic City, N.J. (H. H.

Thomas, 920 S. 19 St., Birmingham 5, Ala.)

3-5. Cooper Ornithological Soc., Berkeley, Calif. (J. Davis, Univ. of California, Hastings Reservation, Jamesburg Route, Carmel Valley.)

5-9. American College of Obstetricians and Gynecologists, Atlantic City, N.J. (J. C. Ullery, 15 S. Clark St., Chicago 3, Ill.)

5-10. American Chemical Soc., 135th, Boston, Mass. (M. A. H. Emery, 18th and K St., NW, Washington, D.C.)

5-10. Nuclear Congress, Cleveland, Ohio. (S. Baron, Burns & Roe, Inc., 160 West Broadway, New York 13.)

6. Paleontological Research Institution,



FISHER CLINICAL ROTATOR

*variable speed ...
for present tests
and future needs*



You can select any rotation rate from 70 to 210 oscillations per minute, at the standard amplitude, when you use the new Fisher Clinical Rotator for micro-flocculation tests. This extended range covers the Kline, Mazzini, VDRL, APHA Reference and other present tests, and provides a generous margin for future revisions or new techniques calling for higher or lower speeds.

Rotation speeds are governor-

controlled within ± 5 cycles, in spite of load or voltage variations. The most-used rates are specially marked on the selector scale. You can set the automatic time-switch for any rotation period up to 25 minutes ... or for continuous oscillation.

The Clinical Rotator's unique removable rubber "tray-top" holds 20 standard 3" x 2" flocculation slides. Its non-skid surface makes slide racks or holders unnecessary.



FISHER SCIENTIFIC

IN THE U.S.A. Cleveland *St. Louis IN CANADA
Boston Detroit *Washington Edmonton
Buffalo *New York
Charleston, W.Va. *Philadelphia IN MEXICO *Montreal
*Chicago *Pittsburgh *Mexico City *Toronto

America's Largest Manufacturer-Distributor of
Laboratory Appliances and Reagent Chemicals

Cat. No. 14-251-200

Price: \$150.00 each

139 FISHER BUILDING
PITTSBURGH 19, PA.

B-88b

Ithaca, N.Y. (R. Harris, 109 Dearborn Rd., Ithaca.)

6-7. Chemical and Petroleum Instrumentation, 2nd natl. symp., St. Louis, Mo. (H. S. Kindler, Director of Technical and Educational Services, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

6-8. American Radium Soc., Hot Springs, Va. (R. L. Brown, Robert Winship Clinic, Emory Univ., Atlanta 22, Ga.)

6-8. Astronautics, AFOSR 3rd annual symp., Washington, D.C. (Headquarters, Air Force Office of Scientific Research, Washington 25.)

6-8. National Open Hearth Steel Furnace, Coke Oven and Raw Materials

Conf., St. Louis, Mo. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

6-9. American Acad. of General Practice, San Francisco, Calif. (M. F. Cahal, Volker Blvd. at Brookside, Kansas City 12, Mo.)

6-11. Coordination Chemistry, intern. conf., London, England. (Chemical Soc., Burlington House, London, W.1.)

12-13. American Soc. for Artificial Internal Organs, Atlantic City, N.J. (C. K. Kirby, ASAIO, 110 Maloney Bldg., University Hospital, 3600 Spruce St., Philadelphia 4, Pa.)

12-16. American Physiological Soc., Atlantic City, N.J. (R. C. Daggs, 9650 Wisconsin Ave., Washington, D.C.)

12-16. Fracture, intern. conf., Cambridge and Dedham, Mass. (Headquarters, Air Force Office of Scientific Research, Washington 25.)

13. Biochemical Cytology of Liver (Histochemical Soc.), symp., Atlantic City, N.J. (A. B. Novikoff, Dept. of Pathology, Albert Einstein College of Medicine, Yeshiva Univ., Eastchester Rd. and Morris Ave., New York 61.)

13-15. Hydraulics Conf. (American Soc. of Mechanical Engineers), Ann Arbor, Mich. (O. B. Schier, ASME, 29 W. 39 St., New York 18.)

13-17. American Assoc. of Immunologists, Atlantic City, N.J. (C. Howe, 630 W. 168 St., New York 32.)

13-17. American Inst. of Nutrition, Atlantic City, N.J. (G. M. Briggs, NIAMD, Room 9D20, Bldg. 10, National Institutes of Health, Bethesda, Md.)

13-17. American Soc. for Pharmacology and Experimental Therapeutics, Atlantic City, N.J. (H. Hodge, Univ. of Rochester, Rochester 20, N.Y.)

13-18. American Acad. of Neurology, Los Angeles, Calif. (J. M. Foley, Boston City Hospital, Boston, Mass.)

13-18. American Soc. of Biological Chemists, Atlantic City, N.J. (F. W. Putnam, Univ. of Florida Medical School, Gainesville.)

13-18. American Soc. for Experimental Pathology, Atlantic City, N.J. (J. F. A. McManus, Univ. of Alabama Medical Center, Birmingham 3.)

14-15. Electrical Heating Conf. (American Institute of Electrical Engineers), Philadelphia, Pa. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

14-16. Life Span of Animals, 5th colloquium on aging, London, England. (Ciba Foundation, 41 Portland Pl., London, W.1.)

14-16. Rheology of the Glassy State (British Soc. of Rheology), Sheffield, England. (D. W. Saunders, British Rayon Research Assoc., Heald Green Laboratories, Wythenshawe, Manchester 22, England.)

15-17. American Assoc. of Genito-Urinary Surgeons, Absecon, N.J. (W. J. Engel, 2020 E. 93 St., Cleveland 6, Ohio.)

15-17. American Surgical Assoc., San Francisco, Calif. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati 29, Ohio.)

16-18. American Assoc. of Railway Surgeons, Chicago, Ill. (C. C. Guy, 5800 Stony Island Ave., Chicago 37.)

16-18. Association of South Eastern Biologists, Knoxville, Tenn. (H. J. Humm, Dept. of Botany, Duke Univ., Durham, N.C.)

16-18. Ohio Acad. of Sciences, Columbus. (G. W. Burns, Ohio Wesleyan Univ., Delaware.)

16-30. Engineering, Marine, Welding and Nuclear Energy Exhibition, 22nd, Olympia, London. (F. W. Bridges & Sons, Ltd., Grand Buildings, Trafalgar Square, London, W.C.2, England.)

17. Current Developments in the Production of High Vacua, symp., London, England. (Institute of Physics, 47 Belgrave Square, London, S.W.1.)

17-18. Nebraska Acad. of Sciences, 69th annual, Lincoln. (M. Beckman, Teachers College, Univ. of Nebraska, Lincoln.)

18-22. American Soc. of Tool Engi-

A TIME LABEL

for every
laboratory
requirement!

It's safe...

SURE and ACCURATE!

TIME self-sticking LABELS are used without wetting. They are fast, safe and provide positive identification with complete safety from hepatitis and other laboratory infections.

They are excellent for use on microscopic slides, bottles (glass and plastic), radioactive containers, animal cages and hundreds of other laboratory uses. They are moistureproof and resist autoclave temperatures to +250°F. or deepfreeze temperatures to -70°F.

BE SAFE... BE SURE... use TIME LABELS! Custom labels and color coding are available for specific requirements.

Write today for complete detailed literature on the outstanding advantages of TIME LABELS.

PROFESSIONAL TAPE CO., INC.
355 BURLINGTON ROAD • Dept. 41-C • RIVERSIDE, ILL.



NEW! CENCO® HYVAC GAS BALLAST PUMPS

For vacuum applications plant and laboratory. Eliminates use of oil separators, centrifuges, refrigerated traps. Wide range of capacities.



Gas Ballast included at no extra cost.

For best possible results use Cenco pump oil. Write today for bulletin 10G.



the most complete line of scientific instruments and laboratory supplies in the world.

CENTRAL SCIENTIFIC CO.

1718-M Irving Park Road • Chicago 13, Illinois
Branches and Warehouses — Mountaineer, N. J.
Boston • Birmingham • Santa Clara • Los Angeles • Tulsa
Houston • Toronto • Montreal • Vancouver • Ottawa

TIME YOUR TESTS IN SPLIT-SECONDS!



GRA LAB

ALL PURPOSE LABORATORY TIMERS

MODELS AT
\$23.95 TO \$29.95

You can set the large 8" dia. for any desired time period within an unusually wide range of 3600 possible settings, (ie., 1 sec. to 60 min., 1 min. to 60 hrs., etc.). At end of preset interval, alarm sounds and external load is automatically switched on or off.

Gra-Lab Micro Timers, Electric Stop Clocks, are available in 1/10 sec. or 1/1000 min. graduations for split-second measurements of elapsed time in laboratory or production operations. Price \$37.50



WRITE FOR COMPLETE CATALOG!

DIMCO-GRAY COMPANY

214 E. Sixth St.
DAYTON 2, OHIO

THE SPECIES PROBLEM

AAAS SYMPOSIUM VOLUME NO. 50

Edited by Ernst Mayr, Harvard University

6 x 9 in., 404 pp., references, index, clothbound, October 1957

Price \$8.75; special cash order price for AAAS members \$7.50

The symposium was arranged by the Association of Southeastern Biologists and cosponsored by AAAS Sections F and G, as well as four other societies. Most papers are published essentially as given in Atlanta in December 1955. Dr. T. M. Sonneborn, however, undertook a comprehensive survey of the species problem in the protozoans and particularly in the ciliates. His masterly synthesis comprising more than two-fifths of the volume is a fundamental contribution to the protozoan literature.

This symposium made a solid contribution toward the solution of the species problem. It broadened the base on which to discuss the problem by utilizing new organisms. It led to a clarification of the areas of general agreement among biologists. It presented a clear statement of the various species concepts and frankly stated and enumerated difficulties in their application to different types of natural populations. Finally, it illuminated certain aspects of the ageless species problem that had been neglected previously, and it attempted a statement of still controversial issues. From these papers it should be evident that the species problem is still one of the important issues in biology.

CONTENTS

Species Concepts and Definitions

Ernst Mayr, *Harvard University*

The Species as a Field for Gene Recombination

Hampton L. Carson, *Washington University*

The Plant Species in Theory and Practice

Verne Grant, *Rancho Santa Ana Botanic Garden and Claremont Graduate School*

The Species Problem in Freshwater Animals

John Langdon Brooks, *Yale University*

The Species Problem with Fossil Animals

John Imbrie, *Columbia University*

Breeding Systems, Reproductive Methods, and Species Problems in Protozoa

T. M. Sonneborn, *Indiana University*

An Embryologist's View of the Species Concept

John A. Moore, *Barnard College and Columbia University*

The Species Problem from the Viewpoint of a Physiologist

C. Ladd Prosser, *University of Illinois*

Difficulties and Importance of Biological Species

Ernst Mayr, *Harvard University*

Index

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

1515 Massachusetts Avenue, N.W., Washington 5, D.C.

16 JANUARY 1959

161

neers, 27th annual, Milwaukee, Wis. (ASTE, 10700 Puritan, Detroit 38, Mich.)

19-23. Oil and Gas Power Conf. (American Soc. of Mechanical Engineers), Houston, Tex. (O. B. Schier, ASME, 29 W. 39 St., New York 18.)

19-24. American Pharmaceutical Assoc., annual conv., Cincinnati, Ohio. (R. P. Fischelis, APA, 2215 Constitution Ave., Washington 7.)

20-21. Recording and Controlling Instruments Conf. (American Inst. of Electrical Engineers), Philadelphia, Pa. (N. S. Hibshman, AIEE, 33 West 39 St., New York 18.)

20-22. American Oil Chemists' Soc.,

spring, 50th anniversary, New Orleans, La. (Mrs. L. R. Hawkins, 35 E. Wacker Dr., Chicago 1, Ill.)

20-23. American Urological Assoc., Atlantic City, N.J. (S. L. Raines, 188 S. Bellevue Blvd., Memphis, Tenn.)

20-23. International Anesthesia Research Soc., 33rd cong., Miami Beach, Fla. (A. W. Friend, IARS, E. 107 and Park Lane, Cleveland 6, Ohio.)

20-24. American College of Physicians, Chicago, Ill. (E. R. Loveland, 4200 Pine St. Philadelphia 4, Pa.)

21-23. American Assoc. for Thoracic Surgery, Los Angeles, Calif. (H. T. Langston, 7730 Carondelet Ave., St. Louis 5, Mo.)

Equipment

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science does not assume responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 166.

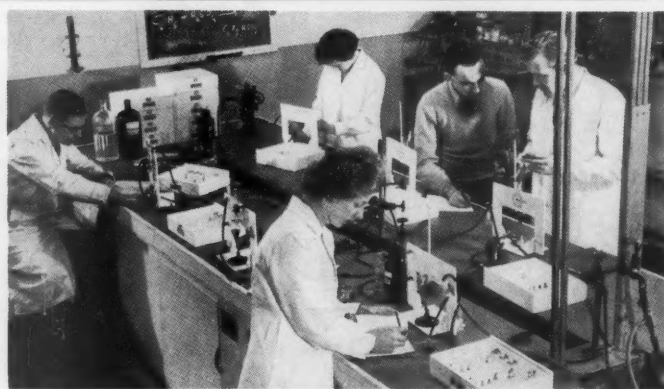
■ **PHOTOELECTRIC POLARIMETER** combines a colorimeter with an adapter unit to permit determination of optical rotation of solutions irrespective of the sign and magnitude of the specific rotation. Moderately turbid and colored solutions can be measured. Precision is approximately 0.05 deg at small angles and 0.1 deg at 20 deg. Since measurements can be made at any wavelength within the visible spectrum, determination of rotatory dispersion is possible. The adapter may be used with existing colorimeters. (Photovolt Corp., Dept. 573)

■ **MASS FLOWMETER** consists of two matched metering components, a variable-force element and a volumetric element. The variable-force element produces a voltage proportional to the product of the square of volume flow and fluid density. The volumetric element produces a frequency proportional to volume flow. The latter is divided electronically into the former to yield mass flow. Accuracy is ± 1 percent of the measured flow. Ranges up to 10^6 lb/hr can be furnished. (Fischer & Porter Co., Dept. 584)

■ **TAPE PUNCH** will accommodate paper tape of either the oiled or unoled variety up to 1 in. wide. Up to eight columns may be punched at operating rates up to 27 punches per second. The unit is designed for console or rack mounting and measures 6 by 11 by $3\frac{3}{4}$ in. (Precision Specialties, Inc., Dept. 585)

■ **DRYING OVEN** for paper chromatographs accommodates three sheets $18\frac{1}{4}$ by $22\frac{1}{2}$ in. A reinforced safety-glass door affords continual viewing of the contents. The oven heats up to a present temperature, up to 110°C , within 20 min. Evacuation of air and solvent vapor is accomplished by connection to a water aspirator. Intake air is heated to the desired temperature. Baffles conceal heating elements and prevent contact of solvent drippings with elements. (New Brunswick Scientific Co., Dept. 587)

■ **ELECTRICAL-INSULATION TAPE** is completely inorganic. The tape consists of 0.004-in. glass cloth saturated and coated on one side with silicone rubber and on the other with silicone thermosetting pressure-sensitive adhesive. Useful temperature range is -50° to $+180^\circ\text{C}$. Thermosetting is accomplished at 500°F . (Minnesota Mining and Manufacturing Co., Dept. 589)



SEMI-MICRO UTILITY SET

This is a Set of Semi-Micro Preparations Apparatus, Consisting of 20 Interchangeable Components and a Specially-Designed Box.

The Box, 28 x 23 x 7 Cm, Has All the Appropriate Spring Clips to Hold Assemblies When in Use, and Also Serves as an Ideal Housing for the Set.

Assemblies for the following uses may be built with the Semi-Micro Utility Set.

REFLUX—as in Acetylation, Nitration and Solution of a solid in a liquid for Recrystallization.

REFLUX WITH ADDITION OF REACTANTS—as Grignard reactions.

VACUUM FILTRATION—as in preparation of derivatives.

PREPARATION—as in final purification of Aniline.

PREPARATION WITH STIRRING—as preparation of Ethyl Acetate. Incorporates a stirrer unit.

RECOVERY—as recovery of solvents.

STEAM DISTILLATION—as distillation of Aniline.

REACTION WITH STIRRING WITH GAS INLET—as Chlorination and preparation in an inert atmosphere.

VACUUM DISTILLATION—as purification of high boiling liquids.

SEPARATION AND EVOLUTION OF GAS—as separation of two immiscible liquids, eg. ether and water.

GAS FLOW REACTION—as estimation of alcohol by oxidation.

REFLUX—reaction under simple reflux.

Cat. No. S-71670—"QUICKFIT" SEMI-MICRO UTILITY SET—consisting of 20 components, mounted in box \$50.00



STANDARD SCIENTIFIC
Supply Corp. 808 BROADWAY
NEW YORK 3, N.Y.

LABORATORY
APPARATUS
REAGENTS
AND
CHEMICALS

■ **DIGITAL VOLTMETER** is accurate to ± 0.015 percent over three automatically switched ranges of ± 10 , ± 100 , and ± 1000 v d-c. Input impedance is 10 megohm at all times. During operation, the voltmeter balances the input signal with a signal from a digital-to-analog converter and presents the converter reading at balance. The measurement is repeated 15 times per second. Output is a dot-projected visual read-out and a ten-line decimal code. The visual read-out shows four digits, polarity sign, and location of the decimal point. (Beckman Instruments, Inc., Dept. 590)

■ **RANDOM-ACCESS MEMORY** uses aperture ferrite plate as the storage medium. Capacity is 512 eight-binary-digit characters. Access time in 12 μ sec. All logic, power-supply, and signal-amplification circuitry is transistorized. Operating temperatures range from 65° to 105°F; no supplemental cooling is required. The system is capable of expansion in both storage capacity and word length. (Rese Engineering, Inc., Dept. 592)

■ **ION-EXCHANGE CELLULOSES** are available in four types. Cellex-E is a monofunctional anion exchanger with only tertiary amine functional groups; Cellex-D is a monofunctional anion exchanger with only tertiary amino functional groups; Cellex-P is a dibase cation exchanger with phosphoric acid functional groups; Cellex-CM is a cation exchanger with only carboxymethyl sites as functional groups. All types are analytical grade. (Bio-Rad Laboratories, Dept. 594)

■ **X-RAY IMAGE INTENSIFIER** covers a useful area of more than 41 in.² with an increase in brightness by a factor of 350 over that obtainable with a fluorescent screen. Contrast between 1.5 to 2.5 percent absorption differences is said to be observable in areas 3/16 to 1/4 in. in diameter. Closed-circuit television is used for viewing. Response speed is great enough to permit movements of the patient to be reproduced without loss of detail. (Zenith Radio Corporation, Dept. 596)

■ **LEVEL GAGE** measures liquid level in totally enclosed containers with accuracy to a few hundredths of an inch. A small radioactive source contained in a float follows the level of liquid along a path predetermined by guide lines placed inside the tank. Radiation is detected by a scintillation detector located outside the tank. The change in radiation is calibrated in terms of volume or linear distance. (Radiation Counter Laboratories, Inc., Dept. 597)

JOSHUA STERN
National Bureau of Standards

16 JANUARY 1959

COCARBOXYLASE

The Pyrophosphate of Thiamine that has been observed to catalyze the oxydative decarboxylation of keto acids and that is proving important—especially as a coenzyme in pyruvic acid conversions. Recent investigations have shown that a number of diseases are accompanied by an increased pyruvic acid level, e.g. diabetic coma and acidosis, pregnancy and infantile toxicoses, acetonaemic vomiting, preeclampsia, eclampsia and severe cardiac and circulatory decompensation. Cocarboxylase will result in the lowering of the pathologically increased pyruvic acid level.

Write for detailed information, literature references and prices.

AET

2-aminoethylisothiuronium bromide • hydrobromide

A NEW RADIATION PROPHYLACTIC

Discovered by Dr. David G. Doherty and associates at Oak Ridge, AET is now offered in commercial supply by Schwarz Laboratories and as tablets for clinical investigation (ANTIRADON). Extensive experiments on mice have shown markedly enhanced survival when AET is administered prior to exposure to lethal radiation. Similar effects have been shown on monkeys. Studies on humans are being conducted currently. The protection provided by AET is believed to result from the formation of free sulfhydryls "in situ" that combine with and detoxify free radicals. This property provides possibilities for other physiological studies, e.g. enzyme activation.

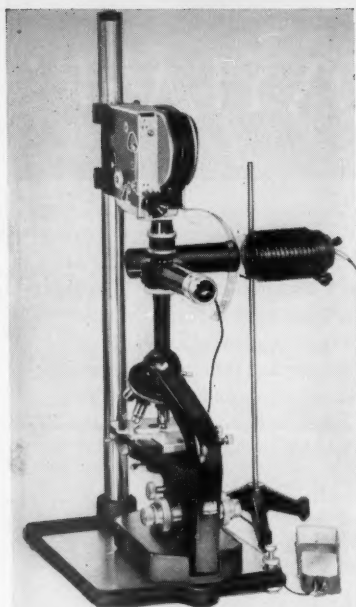
Write for detailed information, literature references and prices.



Write for complete Schwarz Price List

SCHWARZ LABORATORIES, INC.

230B Washington Street, Mount Vernon, New York.



For unparalleled versatility in MICROSCOPY

The Wild M20 microscope is without a peer in the realm of microscopy. This superb example of Swiss craftsmanship and precise optics provides almost unbelievable versatility for both research and scientific exploration.

Available with sextuple nosepiece, built-in 20-Watt illumination source, beam-splitting phototube for binocular focusing during photomicrography... as well as a full range of custom attachments for all observation methods... the Wild M20 is unmatched as a General Purpose or Research Microscope.

Attachments include the Cinetube (shown above), Camera II, Universal Lamp, Equipment and Phase Contrast.

The Wild Cinetube, designed for use with any 16mm movie camera having 50mm or 75mm focal lengths, permits critical focusing on the specimen while actually exposing film. It contains two, built-in, beam-splitters together with a photo electric cell for exposure determination (with a galvanometer) and an internal projection tube for titling or designating pertinent footage.

Your consideration of the Wild M20 will prove most rewarding. Write for Booklet M-20 today.

*The FIRST name in Surveying Instruments, Photogrammetric Equipment and Microscopes

WILD
HEERBRUGG

Full Factory
Services

INSTRUMENTS, INC.

Main at Covert Street • Port Washington, New York
P.O. Box 7-4943

In Canada

Wild of Canada Ltd., 157 Maclean St., Ottawa, Ontario

PERSONNEL PLACEMENT

CLASSIFIED: 25¢ per word, minimum charge \$4.25. Use of Box Number counts as 10 additional words. Payment in advance is required.

COPY for classified ads must reach SCIENCE 2 weeks before date of issue (Friday of every week).

DISPLAY: Rates listed below—no charge for Box number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	\$26.00 per inch
13 times in 1 year	24.00 " " " "
26 times in 1 year	23.00 " " " "
52 times in 1 year	22.00 " " " "

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

Replies to blind ads should be addressed as follows:

Box (give number)
Science
1515 Massachusetts Ave., NW
Washington 5, D.C.

POSITIONS WANTED

Botanist-Plant Physiologist, strong horticultural experience, available summer 1959. Cornell Ph.D., publications, research-administrative experience, age 40. Box 1, SCIENCE. 1/16

Physiologist-Biochemist, Ph.D.; 8 years of industrial and academic research experience in fields of endocrinology, enzymology, carbohydrate and lipid metabolism. Desires challenging research position. Publications. Box 2, SCIENCE. 1/16

Virology-Tissue Culture, D.V.M., Ph.D., 34, excellent experience human and animal viruses. Experimental pathology, cancer. Desires change. Box 9, SCIENCE. 1/23

Zoologist, Ph.D., 10 years of teaching experience. Numerous publications. Box 7, SCIENCE. 1/23

POSITIONS OPEN

Applications are invited for the position **Assistant Professor of Biology** to give instruction in physiology, embryology, and histology. Opportunities for research are available. The salary scale is \$5400-\$7000. A contributory pension scheme is in operation. Moving expenses are payable by the university to a maximum of \$750. Applications containing a complete curriculum vitae and the names and addresses of three referees should be sent to the Head, Department of Biology, Memorial University of Newfoundland, St. John's, Newfoundland. 1/23, 30

Biochemist, Physiologist or Biologist with strong biochemical interests, recent or 1959 Ph.D., desired to participate in basic research on cellular metabolism and renal transport mechanisms. May Institute for Medical Research, 421 Ridgeway Avenue, Cincinnati 29, Ohio. 1/16; 2/20; 3/20; 4/17

Biologists, Ph.D.'s, new state college, southern California. Prefer background in physiology, genetics, embryology, microbiology, or botany. Please send full résumé to Ralph Prator, President, San Fernando Valley State College, Northridge, California. 1/9, 16, 23

(a) **Director of Research**; minimum Ph.D., preferably M.D. or D.V.M.; experience in pharmaceutical field and research capacity required; should be able to organize department and direct staff of 25; \$12,000 to \$18,000; Midwest. (b) **Endocrinologist**, Ph.D. or preferably M.D. with experience in broad aspects of endocrinology; emphasis on medical-biological rather than biochemical side; duties consist of organizing and directing group for endocrinologic research. (c) **Young Biochemist**, Ph.D.; group association; \$8400-\$12,000; California. (d) **Biochemist**, M.S. or Ph.D.; 400-bed general hospital; new diagnostic center and laboratory; college town in New Jersey, few miles from New York; \$6000-\$9000 dependent qualifications. (e) **Publishing Director**; should have certain qualifications in direction of sales and promotions; East. S1-3 Medical Bureau, Burnside Larson, Director, 900 North Michigan, Chicago, Illinois. X

POSITIONS OPEN

Biologist to head scientific staff of growing, established biological supply house. Field collecting experience, plus knowledge of preserving and other biological techniques necessary. Ph.D. degree desired. Administrative ability and teaching experience required. Paid vacations, holidays, benefits, salary opportunities. Box 8, SCIENCE. 1/23, 30; 2/6

Equipment Technician. Background in any area of natural science; 2 years experience in design and construction of laboratory equipment and materials for instructional purposes; B.S. degree preferred. Ability to supervise and train technical nonteaching employees; small college town in northern California; salary: \$4980-6060. Inquiries should be made to Staff Personnel, Chico State College, Chico, California. X

Laboratory Technician. Openings for qualified technicians with backgrounds in any one of following scientific fields: physics, chemistry, biochemistry, immunology, and neurohistology. Salary good. Excellent benefits. Good opportunity for advancement. Write or call Mr. Kay, Personnel Director, Montefiore Hospital, Bronx 67, New York, OLinville 2-7887. 1/16

New World-Wide Graduate Award Directories for American scientists, teachers, librarians to subsidize their education and research. Stipends \$200-\$10,000. Volume I (1957), \$3; volume II (just published, no duplication), \$3; both volumes, \$5. Limited editions. Complete, specific information on 400 awards in United States and overseas in each volume. CRUSADE, Sci., Box 99, Station G, Brooklyn 22, N.Y. eow

Pharmaceutical Product Development. Challenging position, in New York area. Proved background for full responsibility of new product development, contact with clinical investigators, and so forth; growing company. Reply should include record of product development and salary level. Box 5, SCIENCE. 1/16, 23

Ph.D., Experienced in Clinical Chemistry, to supervise group of analytical technicians. Salary \$10,000 or more, depending on experience. Southern California location. Box 255, SCIENCE. 1/16

Ph.D., Biochemistry, recent graduate, to supervise group of technicians for routine and research. Southern California location. Box 256, SCIENCE. 1/16

Physiologist, Psychologist, and Physicist, Ph.D. or M.S. with appropriate experience. Strong research orientation required. To join a rapidly expanding Human Factors and Space Psychology Group. Research presently undertaken by the group covers the fields of perception, human transfer functions, motor response dynamics, analyses of man as a component in complex weapon systems, animal performance in simulated space flight conditions, and other studies related to both conventional and space type weapon systems. Salary will parallel experience and demonstrated achievement. Please send résumé to Mr. C. G. Jones, Manager, Salary Personnel, Goodyear Aircraft Corporation, 1210 Massillon Road, Akron 15, Ohio. 1/23

SCIENCE TEACHERS, LIBRARIANS, ADMINISTRATORS urgently needed for positions in many states and foreign lands. Monthly non-fee placement journal since 1952 gives complete job data, salaries. Members' qualifications and vacancies listed free. 1 issue, \$1.00. Yearly (12 issues) membership, \$5.00. CRUSADE, SCI., Box 99, Station G, Brooklyn 22, N.Y. ew

UNIVERSITY OF ALBERTA. Application is invited for the position of **Assistant Professor Botany**. Applicants should hold the Ph.D. degree and have a well-developed research program in some field of plant physiology. Preference will be given to plant physiologists with a strong background training in biochemistry.

The incumbent would be expected to teach one or more courses in plant physiology and to participate in the elementary program. Every encouragement for research will be afforded.

For this position, the beginning salary will be \$6000 to \$7000 per annum, depending upon the qualifications of the applicant.

Applications should be submitted to Dr. D. E. Sloan, Dean of the Faculty of Arts and Sciences, University of Alberta, Edmonton, Canada, not later than 1 March 1959. Each applicant should provide a curriculum vitae, a transcript of record, a recent photograph, and the names of three references. X

POSITIONS OPEN

Postdoctoral Traineeship in Neuropharmacology
Available for the Ph.D. in chemistry, biochemistry or pharmacology or the M.D. who would like to broaden his training and enter research in neuropharmacology. Stipends from \$4500 per year and up plus dependent allowance. Postdoctoral fellowships in other areas, such as biochemical pharmacology, antibiotics, energy and drug enzymology, are also available. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30; 2/6

FELLOWSHIPS

Research Fellowships in biochemical pharmacology are available for qualified individuals to study for Ph.D. degrees. A background in chemistry is desirable. Stipends begin at \$1800 per year, plus dependent allowance. Write Chairman, Department of Pharmacology, Washington University School of Medicine, St. Louis 10, Missouri. 1/9, 16, 23, 30; 2/6

Announcing University of Louisville Fellowships in Biochemistry for 1959-1960. Predoctoral stipends \$1800-\$2200 annually, tax-free, tuition paid. Dependency and travel allowances as required. Applications should be submitted by 15 February 1959. Also postdoctoral fellowships; apply any time. Write Chairman, Department of Biochemistry, University of Louisville School of Medicine, 101 West Chestnut Street, Louisville 2, Kentucky, for application. 1/23

MELVILLE TRUST FELLOWSHIPS IN CANCER RESEARCH

The Trustees of the above scheme invite applications for Fellowships in Cancer Research commencing in October 1959. The initial stipend will be according to experience, but will be not less than £800 per annum; and funds are available for the provision of equipment and for technical assistance. A fellowship is normally awarded for a period of 2 years, but thereafter may be renewed, at the discretion of the Trustees.

The research is normally to be carried out in one of the recognized clinical or scientific departments in Edinburgh and, if possible, applicants should have made prior contact with the head of the appropriate department. If this is not possible, the Trustees will endeavor to make suitable arrangements.

The research may deal with any aspect of malignant disease, and candidates need not necessarily hold a medical qualification.

Applications, together with the names of three referees, should be submitted by 31 March 1959 to the Honorary Secretary, Scientific Advisory Committee, The Melville Trust, Royal College of Surgeons, Edinburgh 8, from whom further particulars may be obtained. The application should be accompanied by an outline of the proposed research, and by an account of any previous scientific or research experience.

The expenses incurred in traveling to the United Kingdom by any research fellow appointed from overseas will be defrayed by the Trust, which will also reimburse all candidates who are requested to attend for interview. X



The Market Place

BOOKS • SERVICES • SUPPLIES • EQUIPMENT

DISPLAY: Rates listed below—no charge for Box number. Monthly invoices will be sent on a charge account basis—provided that satisfactory credit is established.

Single insertion	\$26.00 per inch
13 times in 1 year	24.00 per inch
26 times in 1 year	23.00 per inch
52 times in 1 year	22.00 per inch

For PROOFS on display ads, copy must reach SCIENCE 4 weeks before date of issue (Friday of every week).

PROFESSIONAL SERVICES

YOU CAN PUBLISH YOUR BOOK

Free illustrated brochure tells how we published, promoted and distributed books for over 3,000 authors under our 40% royalty-subsidy plan. No charge for editorial appraisal of your manuscript. All subjects welcomed. Write Dept. S-1.

EXPOSITION PRESS / 386 4th Ave., N.Y. 16

PROFESSIONAL SERVICES

HISTOLOGY

for
Industry and Research

GEORGE L. ROZSA, M.D.
143 Linwood Ave. Buffalo 9, New York
GRant 7165

Food and Drug Laboratories
Our 36th Year
ANALYSES
EVALUATIONS, CONSULTATION
MAURICE AVE. at 58th ST., MASPETH 78, N.Y.C.
Formerly FOOD RESEARCH LABORATORIES, INC.

PROFESSIONAL SERVICES

LaWALL & HARRISSON

LABORATORY SERVICES for the FOOD & DRUG INDUSTRIES

Drug Evaluation, Food Additive Studies, Chemical and Biological Assays, Clinical Studies, Research

Div. 5, 1921 Walnut St., Philadelphia 3, Pa. • RI 4-4327

HISTOLOGY

MICROBIOLOGY

Consultation
Research Technical Services
SCIENTIFIC LABORATORY SERVICES
2 Melissa Way Terre Haute, Ind.

USE THIS EASY SELF-MAILER to obtain further information

16 January 1959

Readers' Service

Information Requisition

It's simple: Mark—Clip—Fold—Mail—No stamp required

This coupon is for your convenience—to facilitate your requests for further information about advertised products and items in Equipment.

From:

Name Position

Company

Street

City Zone State

(Please print or type)

Mark, clip coupon—FOLD HERE along this line—mail

Postage
Will be Paid
by
Addressee

No
Postage Stamp
Necessary
If Mailed in the
United States

BUSINESS REPLY CARD

First Class Permit #12711 New York, N.Y.

Readers' Service

To: **SCIENCE MAGAZINE**

Room 740

11 West 42 Street

New York 36, New York

Fasten Here Only
Staple, Tape, Glue



INTERESTING — EDUCATIONAL — EASY-TO-BUILD PORTABLE TRANSISTOR RADIO KIT

**Complete—Nothing Else to Buy—
No Soldering—Screwdriver Only Tool Needed**

Here's a challenge and an opportunity for every youngster to build a quality, portable transistor radio that is guaranteed to give amazingly clear reception even from distant stations. This is not an ordinary "crystal set" but a carefully engineered unit utilizing the Germanium Diode developed for radar plus the Transistor for superior amplification of sound.

A screwdriver is the only tool needed. It's simple to follow the step-by-step assembly instructions. The kit contains all necessary components plus a "Trans-Assembly Template." Gift Boxed. You'll be wise to buy several for your own youngster **\$7.95** and lads and lassies on your gift list. **ppd.**

- ★ Simple to Assemble
- ★ Guaranteed to Operate
- ★ Penlite Batteries—Last 1000 hours
- ★ Personal Portable Radio with Case
- ★ Complete with Professional Earphone

Send check or M.O. C.O.D. plus fee. Money Back Guarantee

SCOTT-MITCHELL HOUSE, INC.

Dept. 7101

415 South Broadway, Yonkers, N.Y.

16 January 1959

Readers' Service

Information Requisition

Use this easy self-mailer to obtain further information about items or literature from the Equipment section as well as from advertised products.

EQUIPMENT

Circle below desired number corresponding to:

573	584	585	587	589	590	592
594	596	597				

ADVERTISERS IN THIS ISSUE

In list below, check page number of advertiser from whom you would like more information. If more than one item appears in ad, letters (A, B, C) are used to indicate particular items available in order of appearance in advertisement. Where more than one ad appears on page, "U" indicates upper ad, "L" lower ad, "I" inside ad, "M" middle ad, and "O" outside ad. Advertisements in Personnel Placement and Market Place are not keyed. A multiplicity of items is indicated by *. Readers are requested to specify on this coupon the particular item in which they are interested; otherwise, the request cannot be processed.

<input type="checkbox"/> 114*	<input type="checkbox"/> 115*	<input type="checkbox"/> 116	<input type="checkbox"/> 117	<input type="checkbox"/> 118
<input type="checkbox"/> 119	<input type="checkbox"/> 120	<input type="checkbox"/> 122	<input type="checkbox"/> 153, I	<input type="checkbox"/> 153, O
<input type="checkbox"/> 154	<input type="checkbox"/> 155, UI*	<input type="checkbox"/> 155, LI	<input type="checkbox"/> 155, OA	<input type="checkbox"/> 155, OB
<input type="checkbox"/> 156, U	<input type="checkbox"/> 156, LO	<input type="checkbox"/> 157, A	<input type="checkbox"/> 157, B	<input type="checkbox"/> 157, C
<input type="checkbox"/> 158, UO	<input type="checkbox"/> 158, UI	<input type="checkbox"/> 158, LO	<input type="checkbox"/> 159	<input type="checkbox"/> 160
<input type="checkbox"/> 161, UI	<input type="checkbox"/> 161, UO	<input type="checkbox"/> 162	<input type="checkbox"/> 163, A	<input type="checkbox"/> 163, B
<input type="checkbox"/> 164	<input type="checkbox"/> 167, UI	<input type="checkbox"/> 167, UO	<input type="checkbox"/> 167, L	<input type="checkbox"/> 168

RABBIT BY-PRODUCTS

INCLUDING

SERUM	HEARTS
BRAINS	LIVERS
LUNGS	KIDNEYS
EYES	SPLEENS

All Products From Gov't
Inspected Domestic Rabbits
NATION'S LARGEST SUPPLIER OF
RABBIT BY-PRODUCTS
Write for Free Brochure
PEL-FREEZ Rabbit Meat Co.
Rogers, Arkansas

Sprague-Dawley, Inc.

Pioneers in the development of the
standard laboratory rat.

Sprague-Dawley, Inc.

P.O. Box 2071, Madison 5, Wisconsin
Phone: Cedar 3-5318

FOR SALE

Two Peet-Grady chambers, standard collapsible steel, white enamel inside, with replaceable paper for floor. Also one complete G.E. Air Conditioning Unit, Model FD-30, for chambers and breeding rooms. Also 250 good fly cages. Best offer as unit or separately.

DR. S. I. COHEN

Box 297

Port Jefferson Station, New York

SWISS MICE

BACTERIOLOGICAL AND GROSS
TISSUE STUDY TECHNIQUES USED
IN OUR QUALITY CONTROL

HUNTINGDON FARMS, INC.
2548 NORTH 27th ST. PHILA. 32, PA.

FORMALDEHYDE C¹⁴

other High Radiopurity tagged compounds

ISOTOPES SPECIALTIES COMPANY, INC.
BOX 468 BURBANK, CALIFORNIA
DIVISION OF MIDCOR CORPORATION OF AMERICA, INC.

BOOKS AND MAGAZINES

Your sets and files of scientific journals

are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. Write Dept. A35, CANNER'S, Inc., Boston 20, Massachusetts

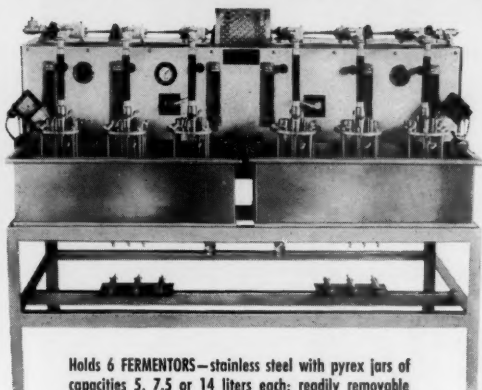
SCIENTIFIC JOURNALS WANTED

Sets, Runs and Volumes bought at top prices.
Your wants supplied from
our Back Files of over 3,000,000 periodicals.
Abrahams Magazine Service; N. Y. 3, N. Y.

FERMENTOR DRIVE ASSEMBLY

For laboratory and pilot plant application

- Aerobic or Anaerobic Fermentations • Tissue Cultures
- Other Metabolic Studies in Submerged Cultures



Holds 6 FERMENTORS—stainless steel with pyrex jars of capacities 5, 7.5 or 14 liters each; readily removable for autoclaving; special leak-proof, non-freezing ball bearing agitator housings.

Stainless steel baths, thermostatically controlled within $\pm \frac{1}{2}^{\circ}\text{C}$. Twin drives afford wide range of agitation and aeration rates.

Machine available with automatic anti-foam addition system. Single and 3-fermentor drive assemblies also available.

Write for Bulletin FS-53



NEW BRUNSWICK SCIENTIFIC CO.

PRECISION LABORATORY APPARATUS

P.O. BOX 606 • NEW BRUNSWICK, N. J.

PHOTOVOLT Line-Operated Multiplier FLUORESCENCE METER Mod. 540



- High-sensitivity for measurement of low concentrations (full-scale setting for 0.001 microgram quinine sulphate)
- Micro-fluorimetry with liquid volumes as low as 1 ml
- Low blank readings, strict linearity of instrument response
- Universally applicable due to great variety of available filters, sample holders, adapters and other accessories
- Interference filters for high specificity of results and for determining spectral distribution of the fluorescent light
- High-sensitivity nephelometry for low degrees of turbidities
- Fluorescence evaluation of powders, pastes, slurries, and solids, also for spot-tests on filter paper without elution

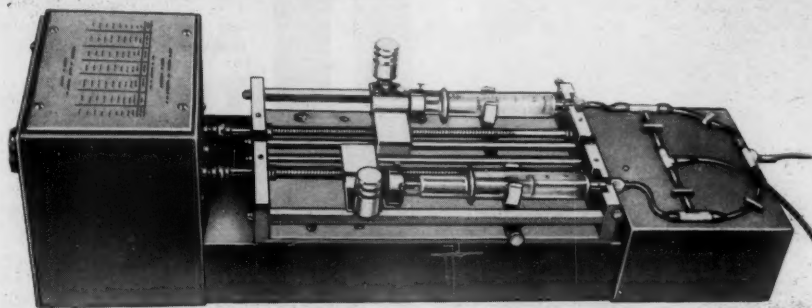
Write for Bulletin #392 to

PHOTOVOLT CORP.

95 Madison Ave.

New York 16, N. Y.

NEW AUTOMATIC PUMP FOR CONTINUOUS INFUSION AND WITHDRAWAL



CATALOG NO. 600-950

The 600-950 is a double infusion-withdrawal unit accomplishing automatic and continuous transfer of large quantities of liquids over extended periods of time. High accuracy is produced by a synchronous motor and precision-cut lead screws. As all actions are automatic, the pump will run continuously without maintenance. Limit stops reverse motor direction and change valves. While one syringe is filling, the other is emptying. Valves are solenoid-operated Hoffman-type clamps acting on the outside of

plastic or rubber tubing. Thus the entire liquid system may be kept sterile. Unit is furnished complete except for syringes.

SPECIFICATIONS

- 12 exact speeds over a 5000-1 range
- 72 separate pumping and withdrawal rates from 38.2 cc./min. to 0.0008 cc./min.
- Reproducibility of $\pm 0.5\%$
- Accepts standard Luer-Lok syringes

\$575.00 — f.o.b. Dover, Mass.

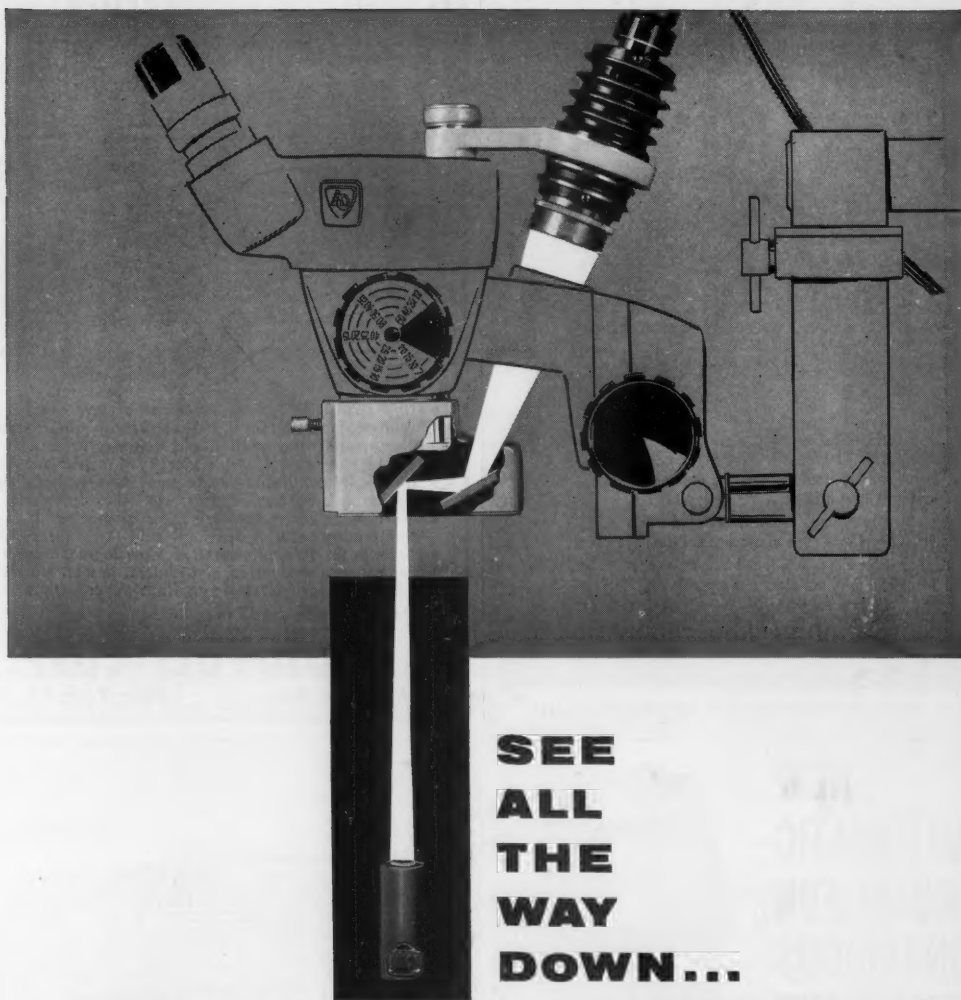
Catalog and Data Sheet available on request



HARVARD APPARATUS CO., INC.

Dover, Mass., U.S.A.

(a non-profit organization)



NEW, AO Spencer Vertical Illuminator allows stereoscopic magnification deep inside small diameter openings

The new Vertical Illuminator and the AO Spencer Cycloptic Stereoscopic Microscope make a unique team that can be the answer to your problem whether it's the inspection of detail in small diameter, deep hole borings, or delicate assembly of miniaturized parts where every move is critical.

This low-cost illuminator readily attaches to the Cycloptic to provide efficient, shadowless illumination deep inside small orifices...and the Cycloptic delivers

realistic, erect, true three-dimensional magnification of the illuminated detail.

The remarkable long working distance afforded by Cycloptic (up to 7 inches when Illuminator is used with 53 and 59 Series) gives you *plus* advantages...permits ample room for large objects or inspection and assembly tools.

Add this unit to your present Cycloptic or ask about low-cost Vertical Illuminator and Cycloptic stereoscopic microscope combinations.

American Optical
Company



SPENCER

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. M-3

Please send me FULL INFORMATION on the NEW AO SPENCER VERTICAL ILLUMINATOR AND CYCLOPTIC MICROSCOPES.

NAME _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

